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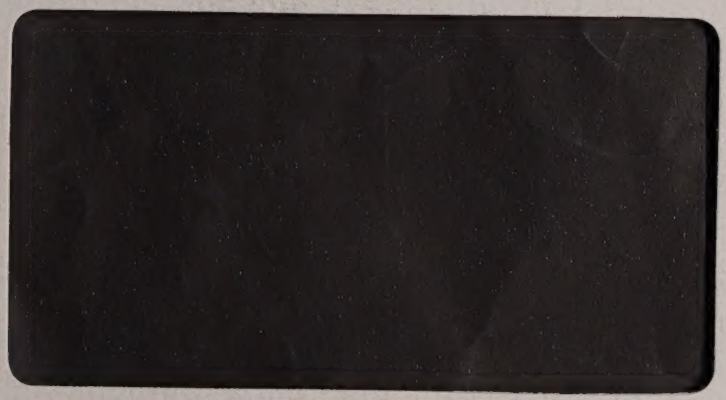

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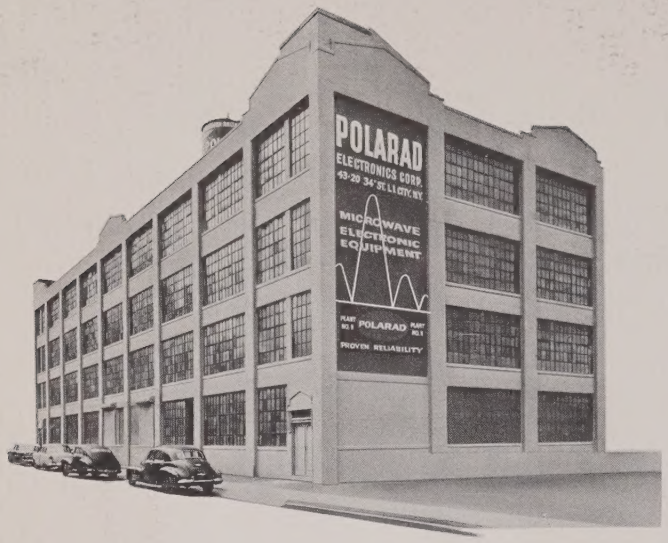

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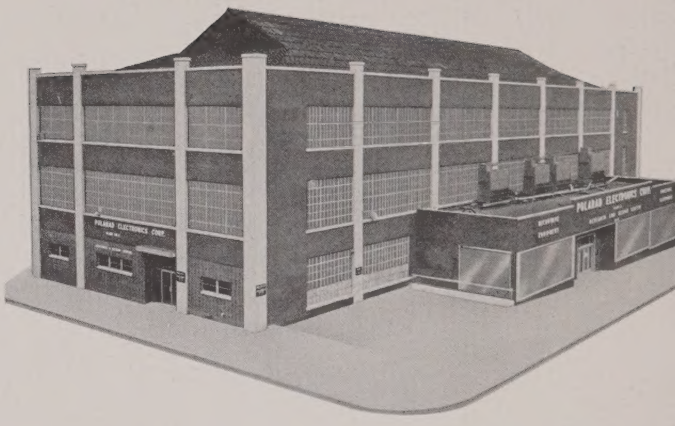

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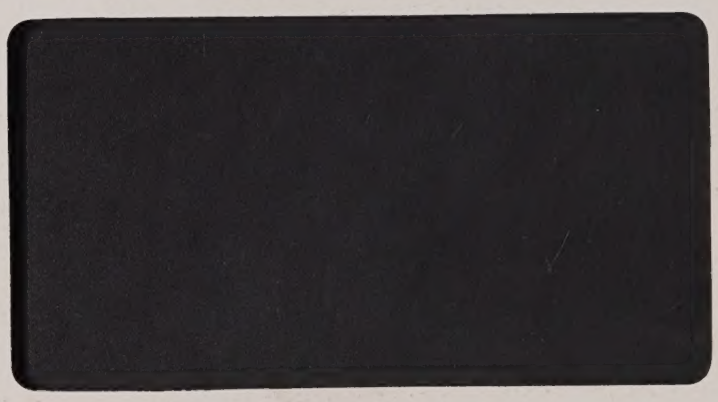

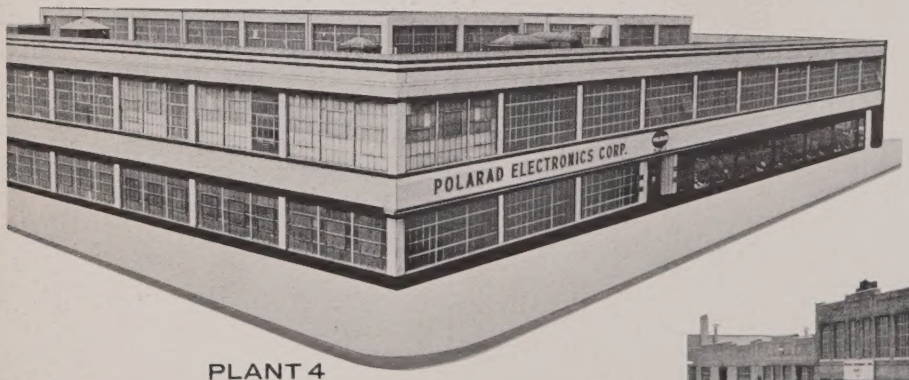

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PROVEN RELIABILITY

INSTRUCTION MANUAL

MICROWAVE
SIGNAL GENERATOR
MODEL MSG-2P
2150 TO 4600 MC

(SERIAL NO. 101 AND UP)

POLARAD ELECTRONICS CORPORATION

43-20 34th STREET • LONG ISLAND CITY 1 • NEW YORK, N. Y.

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TABLE OF CONTENTS

Section		Page
I.	**INTRODUCTION**	
	1-1. Scope of Manual	1
	1-2. Purpose and Use of Equipment	1
	1-3. General Description	1
	1-4. Technical Characteristics	1
	1-5. Electron Tube Complement	2
	1-6. Accessories Supplied	2
II.	**OPERATION**	
	2-1. Function of Controls	3
	2-2. Starting Instructions	5
	2-3. Setting Frequency and Calibrating Power	5
	2-4. Modulation Control Settings	6
	2-5. Modulated Operation	6
	2-6. External Sync Operation	6
	2-7. Pulse Delay Versus Pulse Repetition	6
III.	**PRINCIPLES OF OPERATION**	
	3-1. General	9
	3-2. Klystron Oscillator Circuit	9
	3-3. Power Monitoring Circuit	10
	3-4. Output Attenuator	10
	3-5. Rate Phantastron FM Generator	10
	3-6. Square Wave Generator Circuit	10
	3-7. Undelayed Sync Blocking Oscillator V304A	10
	3-8. Delay Phantastron V309	13
	3-9. Delayed Sync Blocking Oscillator V304B	13
	3-10. Width Multivibrator V310	14
	3-11. Keyer Amplifier V101	14
	3-12. Protective Relays	14
	3-13. Power Supplies	14
	3-14. Functional Operation of the Mechanical Components	14
IV.	**MAINTENANCE**	
	4-1. General	15
	4-2. Access to the Equipment	15
	4-3. Preliminary Inspection Procedures	15
	4-4. Trouble Shooting	18
	4-5. Replacement of RF Klystron Oscillator	25
	4-6. Repeller Power Supply Adjustment	26
	4-7. Beam Current Adjustment	26
	4-8. 115-230 Volt Switching System	26
	4-9. Repeller Voltage Tracking Procedure	26
	4-10. Tracking Adjustment After Replacement of a Track Potentiometer	28
	4-11. Frequency Dial Calibration	28
	4-12. Frequency Dial Correction	28
	4-13. Setting Maximum Prf Adjust R300	29
	4-14. Setting Symmetry Adjust R321	29
	4-15. Setting Maximum Width Adjust R399	29
V.	**PARTS LIST**	
	5-1. Introduction (To Be Supplied)	35

LIST OF ILLUSTRATIONS

Figure		Page
1-1.	Microwave Signal Generator Model MSG-2P	iv
2-1.	Microwave Signal Generator Model MSG-2P, Operating Controls	5
2-2.	Maximum Pulse Delay Versus Pulse Repetition Frequency	7/8
3-1.	Microwave Signal Generator Model MSG-2P, Block Diagram	11/12
3-2.	Klystron Oscillator, Simplified Schematic Diagram	13
4-1.	Microwave Signal Generator Model MSG-2P, Right Side View	21
4-2.	Microwave Signal Generator Model MSG-2P, Basic Unit, Top View, Showing Modulator Unit	22
4-3.	Microwave Signal Generator Model MSG-2P, Basic Unit, Rear View	23
4-4.	Microwave Signal Generator Model MSG-2P, Tuning Unit, Left Rear View	24
4-5.	Microwave Signal Generator Model MSG-2P, Tuning Unit, Top View	24
4-6.	Oscillator Cavity, Exploded View	25
4-7.	Repeller Voltage Tracking, Test Set-up	28
4-8.	Typical Mode Pattern	29
4-9.	Test Set-up for Maximum PRF Adjust R300	30
4-10.	Test Set-up For Symmetry Adjust R321 and Maximum Width Adjust R399	30
4-11.	Test Set-up For Maximum Delay Adjust R367	30
4-12.	Microwave Signal Generator Model MSG-2P, Overall Schematic Diagram, Less Modulator.	31/32
4-13.	Microwave Signal Generator Model MSG-2P, Modulator Unit, Schematic Diagram.	33/34

LIST OF TABLES

Table		Page
1-1.	Electron Tube Complement	2
1-2.	Accessories Supplied	2
2-1.	Operating Controls and Functions	3
2-2.	Modulation Control Settings	6
4-1.	Preliminary Inspection Procedure	16
4-2.	Trouble-Shooting Chart	18
4-3.	Voltage and Resistance Measurements	20
4-4.	Test Equipment Required For Repeller Tracking Procedure	26

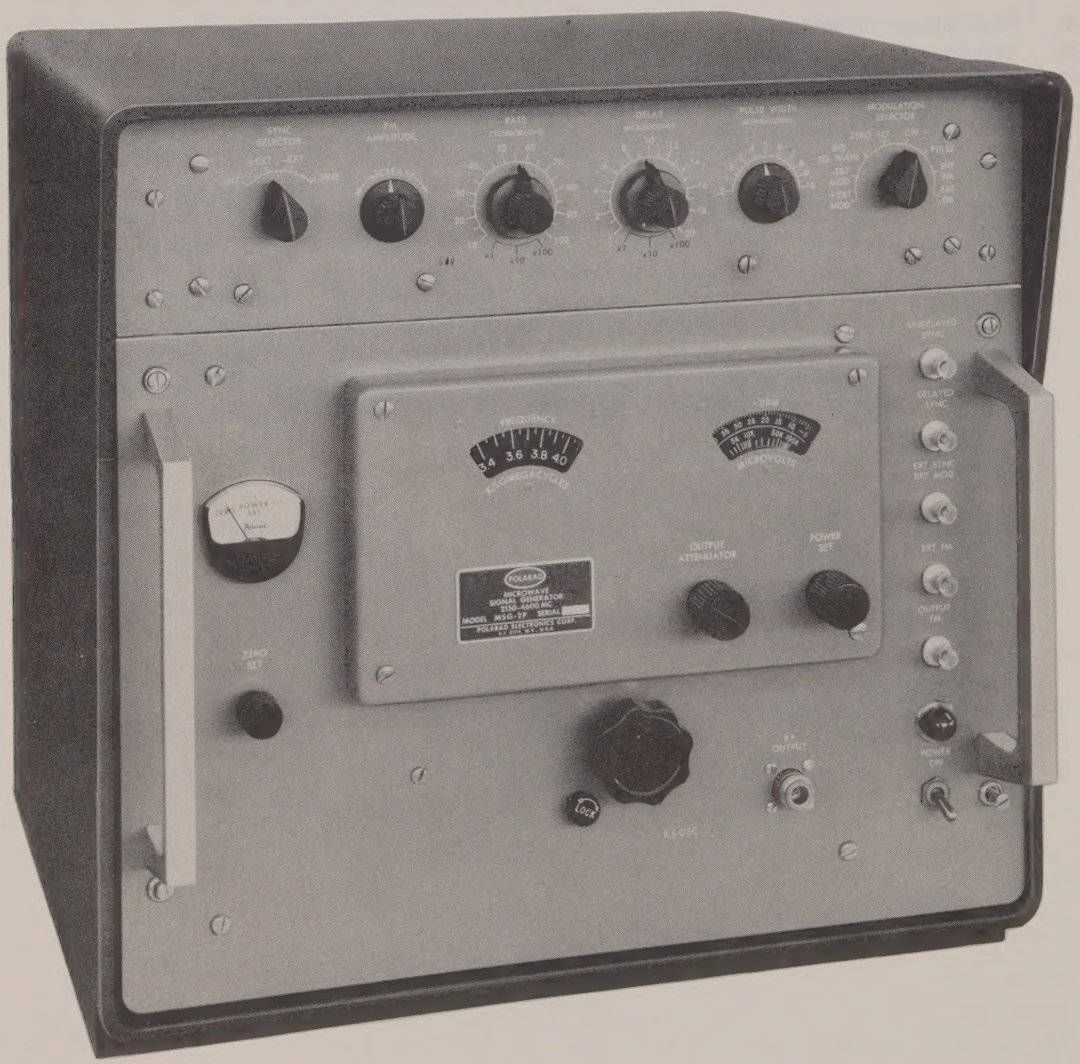


Figure 1-1. Microwave Signal Generator Model MSG-2P.

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL

This instruction manual contains information for the use, operation and maintenance of Microwave Signal Generator, Model MSG-2P (figure 1-1), designed, developed and manufactured by the Polarad Electronics Corporation, Long Island City 1, New York.

1-2. PURPOSE AND USE OF EQUIPMENT

The Polarad Model MSG-2P Microwave Signal Generator is a precision instrument designed to generate cw, fm, square wave, and pulse-modulated radio frequency energy over the frequency range from 2,150 to 4,600 mcs. The Model MSG-2P provides facilities for testing and aligning broad and narrow-band microwave systems and components, such as antennas, radars, receivers, rf amplifiers, attenuators, beacons, crystal mounts, hybrid junctions and preselectors. Specific measurements that can be taken with this equipment include antenna gain, antenna patterns, attenuation, bandwidth, conversion gain, frequency, image rejection, power gain, selectivity, sensitivity, signal-to-noise ratio, SWR, and transmission line characteristics.

1-3. GENERAL DESCRIPTION

The Model MSG-2P Microwave Signal Generator is a versatile instrument which combines high accuracy, simplicity of operation and portability. The equipment is composed of three functional sections, a tuning unit, a modulator, and a basic (power supplies). The Tuning Unit is a separate and removable plug-in unit covering 2,150 to 4,600 mcs. A broadband external-cavity klystron oscillator enables continuous tuning over the complete frequency range. The Modulator Unit is also a separate and removable plug-in unit. The basic unit contains three regulated power supplies which are mounted on removable sub-chassis. This method of construction facilitates servicing and alignment procedures.

The signal generator is housed in a sturdy, attractively hooded aluminum cabinet of modern design, and presents a neat, pleasing appearance. Internal components are cooled by a blower fan mounted in the basic unit which assures reliable operation and longer component life. The complete equipment has been ruggedly constructed to operate dependably through extreme climatic and environmental conditions.

1-4. TECHNICAL CHARACTERISTICS

Power Input..... 115/230 volts ±10% 50-60 cps, 300 watts.

Power Output..... 10 milliwatts (+10 dbm) calibrated.

Frequency Range and Accuracy..... 2,150 to 4,600 mcs, ±1%

Attenuator Output Range and Accuracy..... +10 to -127 dbm, ±3 db between 0 and +10 dbm, ±2 db below 0 dbm.

Output VSWR ..... 2:1 maximum.

Output Connector..... Type N

Modulation..... Internal or external pulse, square wave or fm.

Internal Pulse Modulation:

- Width..... 0.3 to 10 microseconds.
- Repetition Rate..... 10 to 10,000 pps.
- Delay..... 2 to 2,000 microseconds.
- Sync..... Internal, external pulse or sine wave.
- Rise Time..... 0.15 microsecond as measured between 10% and 90% of maximum amplitude of the initial rise.
- Decay Time..... 0.35 microsecond as measured between 10% and 90% of maximum amplitude of the final decay.

Internal Square Wave Modulation:

- Rate..... 10 to 10,000 pps.
- Sync..... Internal.

Internal Frequency Modulation:

- Type..... Linear Sawtooth.

Frequency Deviation. . 5 mc minimum.

Rate..... 10 to 10,000 cps.

Sync..... Internal or external, pulse or sine wave.

External Pulse Modulation:

Polarity..... Positive or negative

Rate..... 10 to 10,000 pps.

Pulse Width..... 0.2 to 50,000 microseconds.

Amplitude..... 15 to 40 volts peak.

Output Sync Pulses:

Polarity..... Positive, delayed and undelayed.

Rate..... 10 to 10,000 pps.

Amplitude..... 15 volts peak minimum.

Rise Time..... Less than 0.25 microsecond.

External Sync:

Type of Input..... Positive, negative or sine wave.

Amplitude..... Pulse: 5 to 50 volts peak; Sine Wave: 5 to 40 volts rms.

Unit Size..... 17 in. wide by 15-1/2 in. high by 14-5/8 in. deep.

Weight..... 95 lbs.

1-5. ELECTRON TUBE COMPLEMENT

Table 1-1 lists the various tubes used in the Model MSG-2P Microwave Signal Generator. See figures 4-1 through 4-5 for the location of these tubes.

TABLE 1-1. ELECTRON TUBE COMPLEMENT

Reference Symbol	Tube Type	Function
Power Supply		
V1	6336	Series Regulator
V2	12AX7	DC Amplifier
V3	OB2	Voltage Regulator
V4	5Y3	Rectifier
V5	6080	Series Regulator
V6	12AX7	DC Amplifier
V7	5Y3GT	Rectifier
V8	6AQ5	Series Regulator
V9	12AX7	DC Amplifier
V10	5651	Voltage Regulator
Tuning Unit		
V13	K5836	Klystron Oscillator
V100	5814	Beam Current Regulator
V101	5687	Keyer Amplifier
Modulator		
V301	5725	Rate Phantastron and FM Generator
V302	6U8	A-Cathode Follower B-Square Wave Generator
V303	12AU7	A-Puller Amplifier B-Puller Amplifier
V304	5687	A-Undelayed Sync Blocking Oscillator B- Delayed Sync Blocking Oscillator
V305	6U8	A-Phase Inverter B-Clipper Amplifier
V306	5687	Schmitt Trigger
V307	6CL6	Output Amplifier
V308	12AU7	A-Cathode Follower B-Buffer Amplifier
V309	5725	Delay Phantastron
V310	6AN8	Width Multivibrator

1-6. ACCESSORIES SUPPLIED

The following accessories are supplied with the Model MSG-2P Microwave Signal Generator.

TABLE 1-2. ACCESSORIES SUPPLIED

Accessory	Part Number
1 - Line Cord (AC)	B111144
1 - RF Cable	BP12551
1 - Video Cord	BP12553
1 - Wrench Kit	A25109

SECTION II
OPERATION

2-1. FUNCTION OF CONTROLS

Haphazard operation or improper setting of the controls can cause damage to this instrument. It is important to know the function of every control, indicator, and connector before energizing the equipment. Table 2-1 lists the front panel designations of operating controls, indicators, connectors and their functions. See figure 2-1 for their locations.

TABLE 2-1. OPERATING CONTROLS AND FUNCTIONS

Controls, Indicators or Connectors	Function
POWER INPUT 115/230 V 50-60 CPS receptacle	(Located at rear of dust cover) Connects signal generator to 115 or 230 volt, 50-60 cps source.
POWER ON switch and indicator	When in an on position, the switch applies ac power to the instrument and the indicator glows.
MODULATION SELECTOR switch	Permits selection of cw, fm (internal or external), square wave or pulse modulated output (internal or external).
PULSE WIDTH MICROSECONDS control	Permits adjustment of the rf pulse width from 0.3 to 10 microseconds when MODULATION SELECTOR switch is in PULSE position.
DELAY MICROSECONDS control	Permits adjustment of the delay between the rf output pulse and undelayed sync pulse over the range from 2 to 2,000 microseconds.
RATE CYCLES/SECOND control	Determines the modulation repetition rate when SYNC SELECTOR is in INT position.
FM AMPLITUDE control	Sets the magnitude of the sawtooth signal applied to the repeller of the klystron when MODULATION SELECTOR switch is in INT FM position.
SYNC SELECTOR switch	INT position: Allows the internal rate generator circuit to control the modulation repetition rate. +EXT, -EXT positions: Permits use of either positive or negative external signals, single pulse or multipulse, for modulation of the klystron repeller. With the MODULATION SELECTOR switch set at internal positions, an external sync can be used to determine the prf of the generator. SINE position: Permits use of sine wave input for modulating klystron repeller.

TABLE 2-1. OPERATING CONTROLS AND FUNCTIONS(continued)

Controls, Indicators or Connectors	Function
ZERO SET control	Permits balancing of the internal thermistor bridge so that the POWER SET meter indicates ZERO.
POWER SET meter	Indicates when proper adjustment of the klystron cavity is achieved.
POWER SET control	Permits adjustment of the external klystron cavity so that POWER SET meter indicates POWER SET.
R. F. OSC. control and FREQUENCY KILO-MEGACYCLES dial	Selects desired frequency which appears on the FREQUENCY KILOMEGACYCLES dial. Use of dial lock prevents accidental rotation of this control.
OUTPUT ATTENUATOR control and -DBM MICROVOLTS dial	Reduces the rf output voltage to known levels below a measured reference level as indicated on the -DBM MICROVOLTS DIAL.
RF OUTPUT connector	Connects the rf power output from the output attenuator to the equipment under measurement.
UNDELAYED SYNC connector	Supplies a positive trigger which leads the rf pulse in time when MODULATION SELECTOR switch is in FM or PULSE positions.
DELAYED SYNC connector	Supplies a positive trigger coincident with the rf pulse when MODULATION SELECTOR switch is in INT FM or PULSE positions.
EXT SYNC EXT MOD connector	Receives an external sync signal to set the repetition rate without using the internal rate generator or an external modulation signal to modulate the klystron repeller.
EXT FM connector	Receives an external signal to modulate the klystron repeller with MODULATION SELECTOR switch in EXT FM position.
OUTPUT FM connector	Supplies sawtooth output for external use.

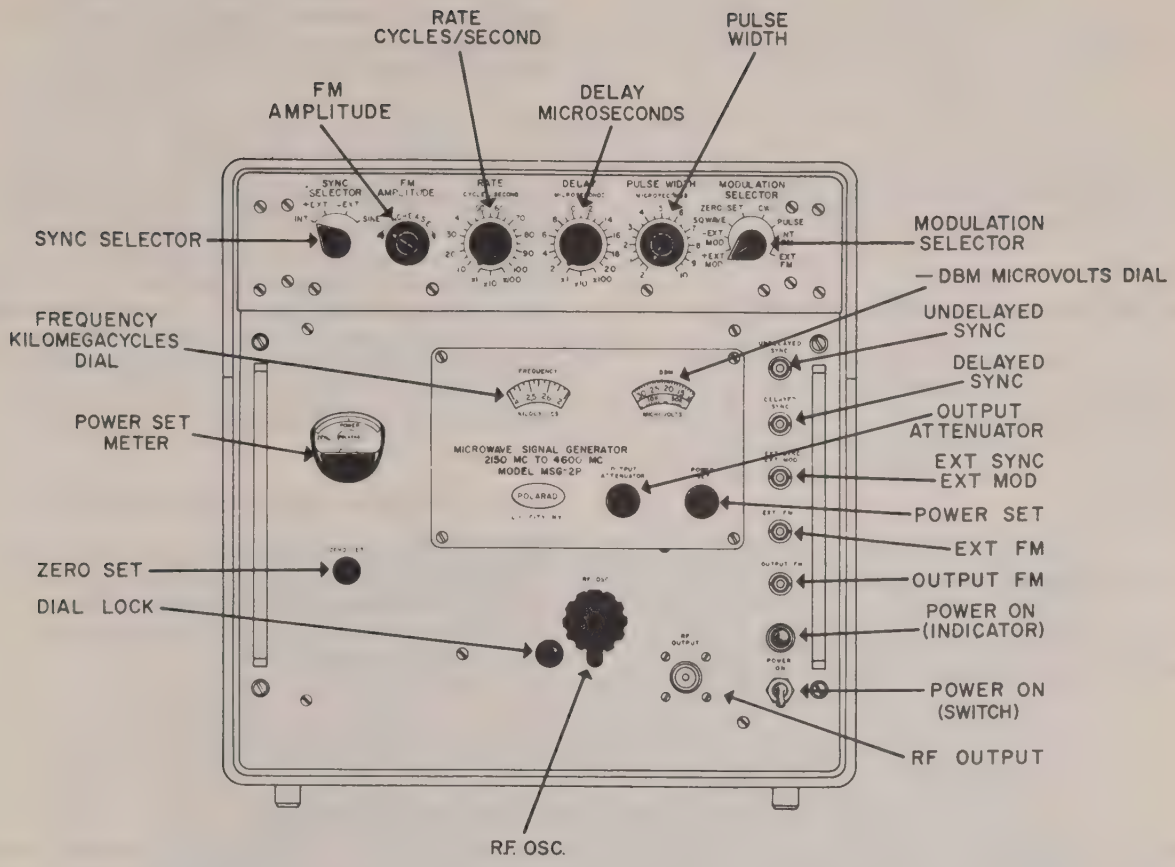


Figure 2-1. Microwave Signal Generator Model MSG-2P, Operating Controls

2-2. STARTING INSTRUCTIONS

The following instructions should be followed to ensure proper operation of the Model MSG-2P Microwave Signal Generator.

a. The 115V-230V input switch of the unit is normally factory set at 115 volts. If it is desired to use a 230 volt input to the equipment, set the internal input switch to 230 volts. To reach the switch, remove the dust cover by setting the equipment face down, loosening the camlocks located at each corner of the rear of the dust cover, and sliding the case upward.

b. Connect a 115 or 230 volt, 50-60 cycle, single phase source to the power input receptacle, at the rear of the equipment, using the ac line cord supplied.

c. Throw the POWER ON switch to an on position. The POWER ON indicator should light.

d. Allow the signal generator to warm up for at least 15 minutes.

2-3. SETTING FREQUENCY AND CALIBRATING POWER

The following procedure should be used to set the frequency and to calibrate the output power of the Model MSG-2P.

a. Turn the R. F. OSC. control until the FREQUENCY KILOMEGACYCLES dial indicates the desired frequency.

b. Set the MODULATION SELECTOR switch to ZERO SET. This makes the oscillator inoperative.

c. Adjust the ZERO SET control until the POWER SET meter pointer is at ZERO.

d. Set the MODULATION SELECTOR switch to CW.

e. Adjust the POWER SET control until the POWER SET meter pointer is at the POWER SET line. The signal generator is now at the one-milliwatt power reference level for the frequency set in step a.

f. Rotate the OUTPUT ATTENUATOR control until the -DBM MICROVOLTS dial is set to the desired value of rf signal level.

NOTE

Whenever the frequency is changed, it is necessary to repeat the power calibration procedure given above.

2-4. MODULATION CONTROL SETTINGS

The control settings to obtain the various types of modulation available are listed in table 2-2. If the instructions in paragraph 2-3 have been followed, the output in CW, PULSE and SQ WAVE positions of the MODULATION SELECTOR switch will be peak power.

2-5. MODULATED OPERATION

When the signal generator is switched into modulated operation, the klystron keying voltage can be supplied by an external pulse or an internal pulse, or a sawtooth wave. Delayed and undelayed sync pulses are externally available when the modulator section supplies the keying voltage.

2-6. EXTERNAL SYNC OPERATION

With the MODULATION SELECTOR at INT FM or PULSE, and the SYNC SELECTOR in SINE, +EXT or -EXT, an external wave-form applied at the EXT SYNC EXT MOD front panel connector is fed through pulse shaping circuitry and delay circuitry to trigger V301. By setting the RATE CYCLES/SECOND control at a slightly lower rate than the externally applied signal, the generated signal will be controlled by the rate of the external signal.

2-7. PULSE DELAY VERSUS PULSE REPETITION

Figure 2-2 shows the maximum permissable setting of the DELAY controls for pulse repetition rates within the pps range of the equipment. A delay setting greater than depicted by the curve will result in a false indication.

TABLE 2-2. MODULATION CONTROL SETTINGS

MODULATION SELECTOR SETTING	OUTPUT	SYNC SELECTOR POSITION	RATE CYCLES/SECOND POSITION	SYNC PULSE OUTPUT	FRONT PANEL INPUT CONNECTOR	REMARKS
1. CW	CW	Not operative	Not operative	None	None	----------
2. PULSE	Pulse modulated	INT	10-10,000 as desired	Delayed and undelayed	None	Use PULSE WIDTH and DELAY controls as required.
3. +EXT MOD -EXT MOD PULSE	Pulse modulated	+, - or SINE	Set just below sync rate of external sync signal	Delayed and undelayed	EXT SYNC EXT MOD	Use PULSE WIDTH and DELAY controls as required.
4. SQ WAVE	Square wave modulated.	INT	10-10,000 as desired	Delayed and undelayed	None	----------
5. INT FM	FM	INT	10-10,000 as desired	Delayed and undelayed	None	Use FM AMPLITUDE control as required

TABLE 2-2. MODULATION CONTROL SETTINGS (continued)

MODULATION SELECTOR SETTING	OUTPUT	SYNC SELECTOR POSITION	RATE CYCLES/SECOND POSITION	SYNC PULSE OUTPUT	FRONT PANEL INPUT CONNECTOR	REMARKS
6. INT FM	FM	+, - or SINE	Set just below sync rate of external sync signal	Delayed and undelayed	EXT SYNC EXT MOD	Use FM AMPLITUDE control as required.
7. EXT FM	FM	Not operative	Not operative	None	EXT FM	----------

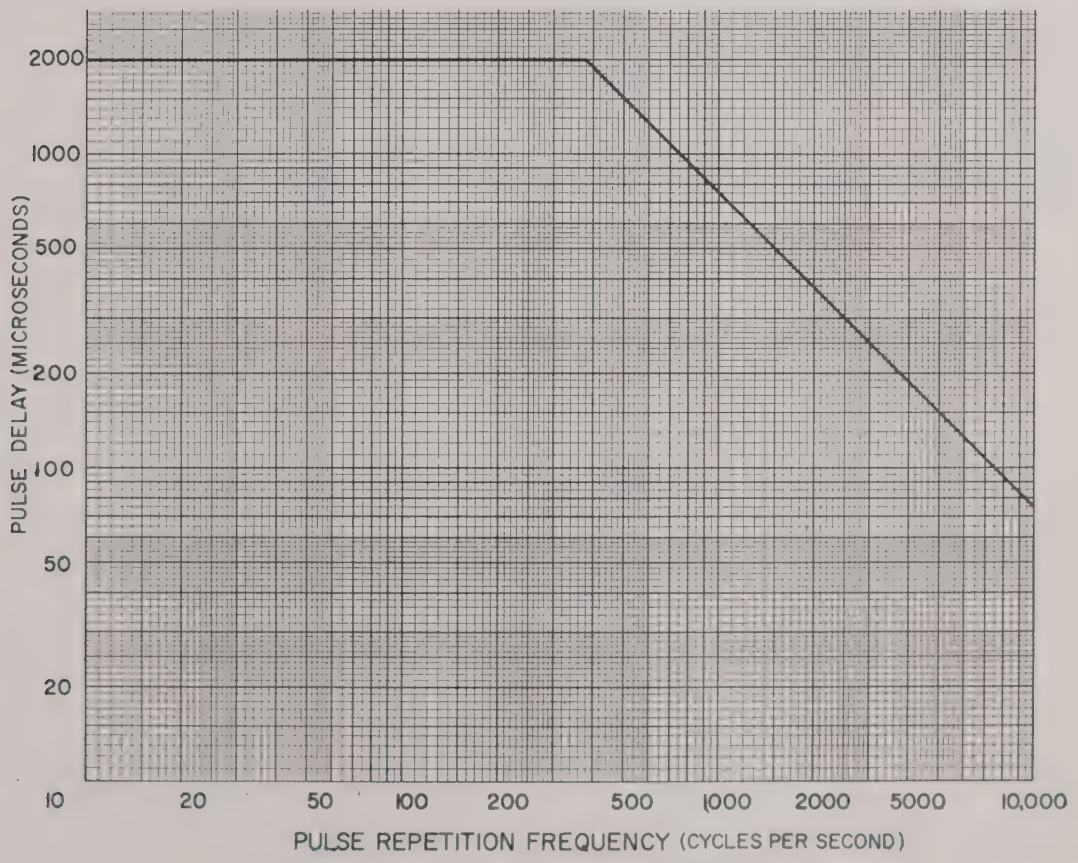


Figure 2-2. Maximum Pulse Delay versus Pulse Repetition Frequency.

SECTION III
PRINCIPLES OF OPERATION

3-1. GENERAL

The basic principles of the Polarad Microwave Signal Generator Model MSG-2P can be understood from examination of the block diagram shown in figure 3-1. The signal generator provides continuous-wave, pulse-modulated, square wave-modulated or frequency modulated signals of known intensities and frequency in the frequency range from 2,150 to 4,600 mcs.

The Model MSG-2P consists essentially of an rf reflex klystron oscillator operating in an externally tuned cavity, a modulator, a keyer, a power-monitoring bridge circuit, and three self-contained electronically regulated power supplies.

The oscillator circuit consists of a reflex klystron tube and its associated external resonant cavity. The function of the modulator and keyer circuits is to generate a modulation voltage, either pulse, square wave, or sawtooth in waveform, and to apply this voltage to the reflex klystron. When pulse or square wave amplitude modulation is used, the amplitude modulated signal is applied to the grid of the klystron tube. When frequency modulation is employed, the sawtooth signal from the modulator circuit is applied to the repeller electrode of the klystron.

The Model MSG-2P is a free-running pulse generator when the SYNC SELECTOR switch is in the INT position and the MODULATION SELECTOR switch is in PULSE, SQ WAVE or INT FM position. In the other positions of the SYNC SELECTOR, an external signal (of sinusoidal, square-wave or pulse-wave form) can be applied to the modulator. After being shaped by pulse-shaping circuits (V305B and V306), this externally applied sync signal controls the repetition rate of the modulator.

Delay phantastron V309 within the modulator is used to develop a variable delay within the range from 2.0 to 2,000 microseconds. The modulator also includes two blocking oscillators (V304A and V304B) which generate sync output signals. One sync output is coincident with the rate phantastron output; the other is coincident with the delayed pulse that is applied to the keyer. These delayed and undelayed pulses and an internal fm sawtooth output are also available for external use.

The R. F. OSC. knob controls the movement of both a tracking potentiometer, which varies the klystron repeller voltage, and a non-contacting plunger within the external cavity, which selects the desired frequency. The non-contacting feature of the plunger assembly eliminates tuning noise and guarantees long equipment life.

The power monitoring circuit consists of a Wheatstone bridge in which a sliding thermistor probe, positioned by the POWER SET control, is one arm of the bridge. The thermistor probe is located in one of the two waveguide-beyond-cutoff tubes which project from the sides of the klystron cavity. Adjustment of the thermistor probe affects the power absorbed by the thermistor, thereby changing its resistance. Consequently, the bridge is unbalanced and a pointer deflection on the POWER SET meter is indicated. The one-milliwatt power reference level is established, first, by balancing the bridge with no rf power applied, and second, by adjusting the thermistor probe until the pointer on the POWER SET meter deflects to the POWER SET line. A sliding pick-up loop in the other waveguide-beyond-cutoff tube is employed to set the rf power output. This adjustment is controlled by the front panel OUTPUT ATTENUATOR. When the power reference level has been set, and the -DBM MICROVOLTS dial reads "0", one milliwatt of rf power is available at the RF OUTPUT connector. When the MODULATION SELECTOR switch is in ZERO SET position, there is no rf output available at the RF OUTPUT connector.

3-2. KLYSTRON OSCILLATOR CIRCUIT

The oscillator circuit (see figure 3-2) uses a reflex klystron tube, operating in an externally tuned cavity, which generates cw signals. The klystron cavity is in the form of a coaxial transmission line consisting of two cylinders, one inside the other. The klystron tube is inserted at one end of this transmission line so that the outer cylinder makes contact with the first interaction grid (so termed because it is closer to the cathode), while the inner cylinder makes contact with the second interaction grid. At the other end, the resonator "short" circuit is completed by a movable non-contacting plunger of special electrical design. The R. F. OSC. tuning knob, located on the front panel, controls the movement of the plunger within the cavity to set the resonator frequency. Simultaneously, this control adjusts tracking potentiometer R96 which applies the proper voltage to the klystron repeller (sometimes called "reflector") to insure operation within its repeller mode. Rotation of the R. F. OSC. knob also actuates the automatic mode selector switch S2, thereby switching the repeller voltage modes. The waveguide-beyond-cutoff tubes, projecting from the cavity, couple rf energy to the attenuator and the power monitor. Protective diode CR101 is connected between the repeller and cathode of the klystron tube to keep the repeller from going positive with respect to the cathode, which would damage the klystron.

3-3. POWER MONITORING CIRCUIT

The rf power monitor circuit (see figure 4-12) is used to calibrate the output of the attenuator. The power monitoring circuit consists of a Wheatstone bridge of which one arm is a variable resistance element (thermistor RT1) which measures the power. A thermistor has a negative temperature coefficient of resistance. As its temperature increases, its resistance decreases, and conversely as temperature decreases, resistance increases. Changes in thermistor temperature, and hence resistance, are governed by three factors. These are: thermal changes in its environment; the current flowing through it, and absorbed rf power. By controlling the current required for balance, the bridge can be used to determine the rf power by measuring the change in thermistor resistance caused by the applied rf power. Two types of thermistors are used in the power monitoring circuit; a bead type (RT1) and disc type (RT2 and RT3). The bead thermistor, used for power measurement, has a small mass and is affected by all of the changes mentioned above. The disc thermistor, used in compensating networks, has a large mass and its resistance is relatively insensitive to the current flowing through it. The disc thermistor is dependent, primarily, on the ambient temperature.

The basic bridge circuit is balanced (the ZERO line on POWER SET meter) by adjusting front panel ZERO SET potentiometer R203. Coarse Adj potentiometer R17 is factory adjusted to permit the ZERO SET control to cover the entire temperature operating range and normally need not be adjusted. Movement of the bead thermistor is controlled by the POWER SET control on the front panel. For a given frequency, this thermistor is inserted into the cutoff waveguide so that one milliwatt of rf power is indicated by the POWER SET meter pointer deflecting to the POWER SET line.

3-4. OUTPUT ATTENUATOR (See figure 4-12.)

Attenuator TR101 couples the resonant frequency output of the klystron oscillator to the RF OUTPUT receptacle on the front panel. TR101 is a piston attenuator assembly inserted into the waveguide-beyond-cutoff tube. This assembly is positioned by the front panel OUTPUT ATTENUATOR control through a rack and pinion gear. The -DBM MICROVOLTS dial affords a direct reading of the output in decibels below a one milliwatt reference level with a 50-ohm resistive load. The setting on the one milliwatt reference level is a function of the power monitoring circuit discussed in the preceeding paragraph.

3-5. RATE PHANTASTRON FM GENERATOR (See figure 4-13.)

Rate phantastron fm generator V301 supplies the necessary triggers for square wave modulation and frequency modulation, at a controlled repetition rate. The repetition rate is determined by the value of capacitance switched into the control grid circuit of the phantastron by means of Rate Multiplier S302, and by the value of resistance set by RATE CYCLES/SECOND control R301, in conjunction with the internal Max. Prf Adjust R300.

The maximum PRF adjustment is used to set the pulse rate limit. The output from the plate of phantastron V301 is fed to the grid and cathode circuit of cathode follower V302A. In fm operation the sawtooth output from the cathode of V302A is controlled by the front panel FM AMPLITUDE control R318.

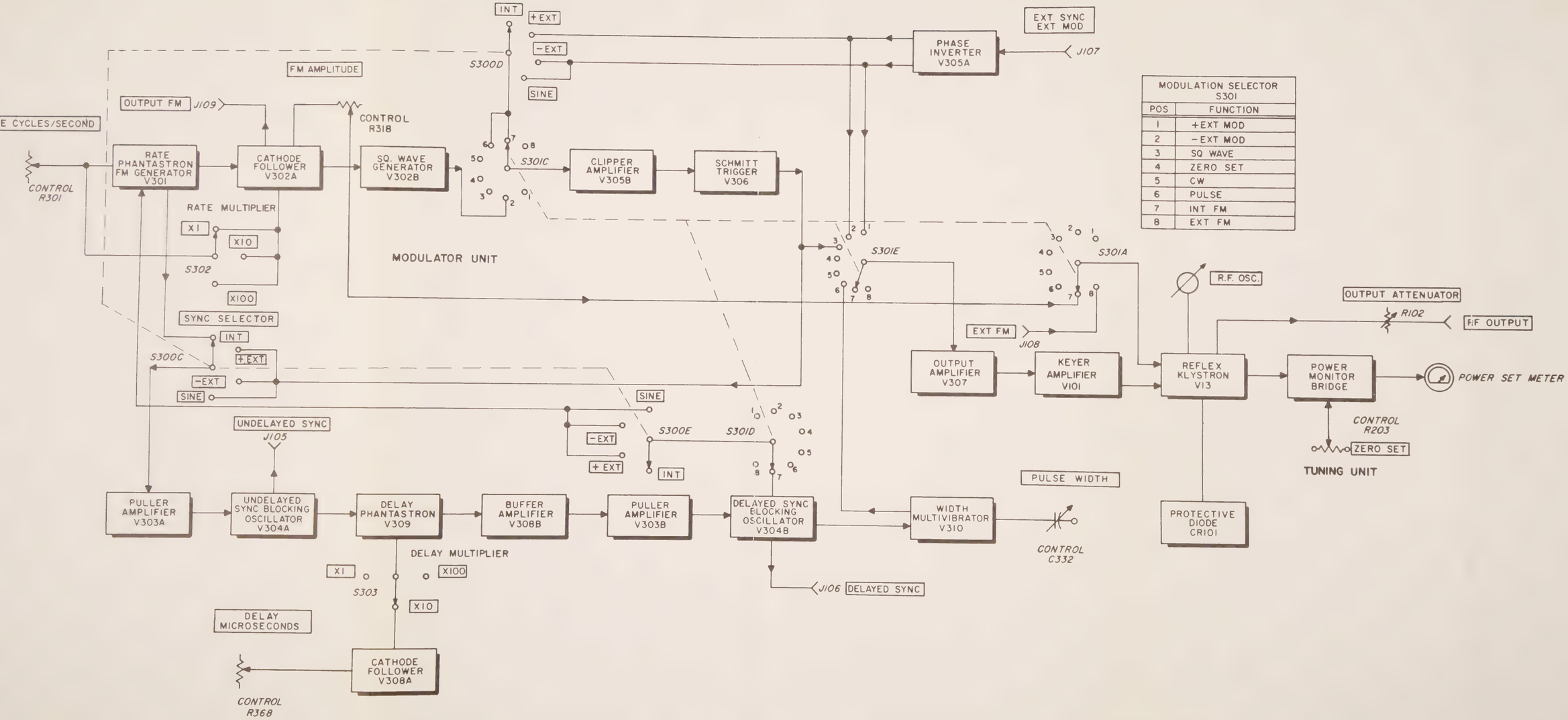
3-6. SQUARE WAVE GENERATOR CIRCUIT

In square wave operation the sawtooth signal from cathode follower V302A is fed to square wave generator V302B. Symmetry adjustment R321 is used to set an exact requirement of 50 percent of peak value of the sawtooth voltage which appears at the grid of V302B as minimum bias voltage for the tube to conduct. The output of V302B is therefore composed of symmetrical pulses which are the upper peaks of the sawtooth signal.

After amplification the signal is then coupled to Schmitt trigger V306. The schmitt trigger circuit has a constant peak value output (a flat-topped pulse) which is independent of the shape of the input voltage waveform. The duration of the positive portion of the square wave output corresponds to the period that the input waveform exceeds a specific voltage. The square wave generated from the plate of V306B is then fed through MODULATION SELECTOR switch S301E to output amplifier V307 which applies it to the keyer circuit in the Tuning Unit.

3-7. UNDELAYED SYNC BLOCKING OSCILLATOR V304A

In pulse operation using internal sync, puller amplifier V303A receives the differentiated screen waveform from phantastron rate generator V301 and couples the signal to undelayed sync blocking oscillator V304A. This is a triggered blocking oscillator which provides sharp pulses of less than 0.1 microsecond rise time, with a minimum positive amplitude of 15 volts. These pulses are available at the UNDELAYED SYNC output receptacle on the front panel. The undelayed sync pulse leads the leading edge of the modulated test signal by the amount indicated by the DELAY controls.



MODULATION SELECTOR S301

POS	FUNCTION
1	+EXT MOD
2	-EXT MOD
3	SQ WAVE
4	ZERO SET
5	CW
6	PULSE
7	INT FM
8	EXT FM

Figure 3-1. Microwave Signal Generator Model MSG-2P, Block Diagram

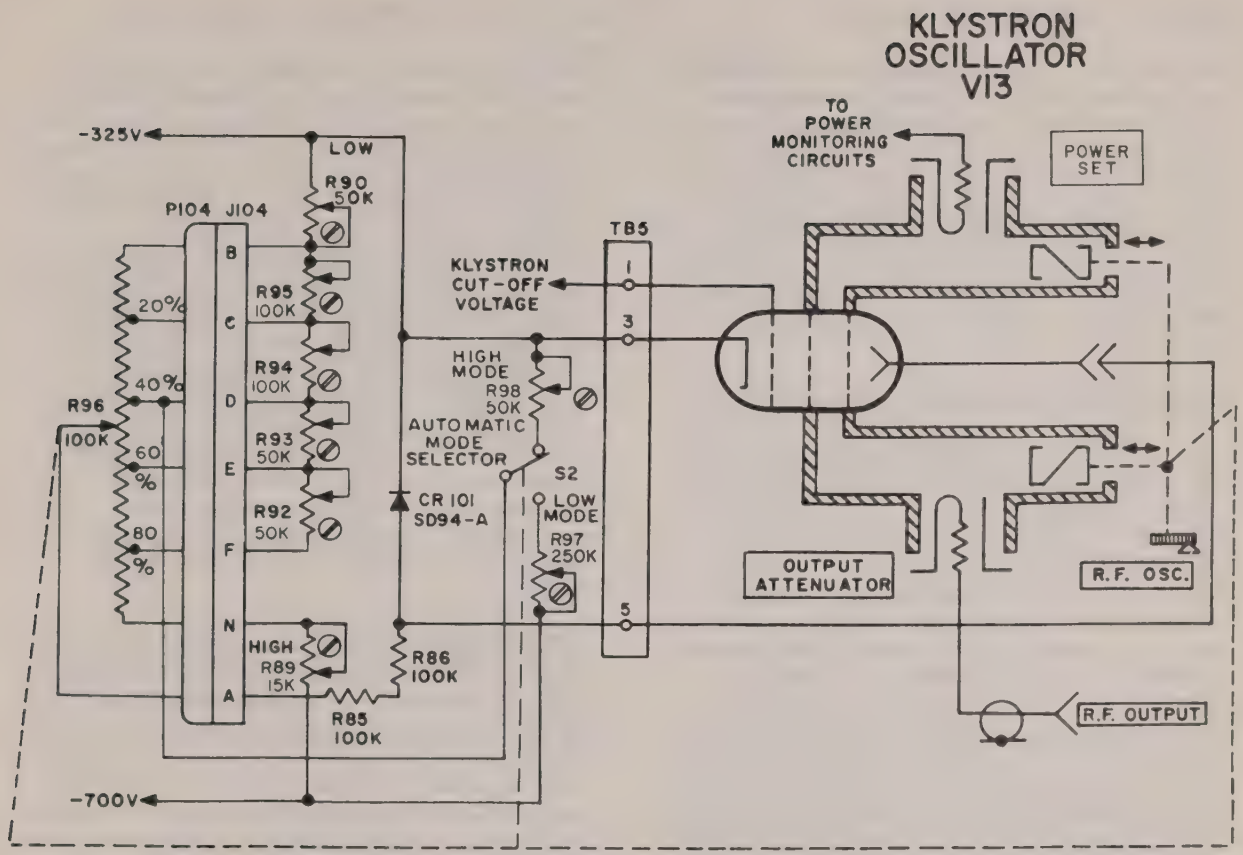


Figure 3-2. Klystron Oscillator, Simplified Schematic Diagram.

3-8. DELAY PHANTASTRON V309

The trigger at the cathode of V304A is coupled to the suppressor grid of delay phantastron V309 through CR303, which clips the negative peaks. V309 is a screen-coupled phantastron circuit with a speed-up cathode follower (V308A). The positive trigger applied to the suppressor grid allows the plate of the phantastron tube to draw current. When this happens, the plate voltage drops, the grid voltage drops proportionally, the cathode current falls and the screen voltage rises. This action causes the suppressor voltage to rise because it is obtained from the same bleeder circuit as is the screen potential. The plate voltage then runs down linearly as in a conventional Miller circuit. The end of this period comes when the control grid goes positive again, resulting in an increase of cathode current, in suppressor cutoff and heavy screen current. The delay is adjusted with Delay Multiplier S303. The Delay Multiplier selector switches different value capacitors into the cathode-to-grid circuit, which change the delay range. Max. Delay Adjust R367 is used to set the maximum delay of the phantastron circuit. DELAY MICROSECONDS potentiometer R368 is the fine delay control on the front panel of the equipment.

The delayed pulse from the suppressor grid of V309 is fed to the grid of buffer amplifier V308B. Buffer amplifier V308B and puller amplifier V303B serve to isolate, amplify, invert and differentiate the output signal. The resulting positive pulse is coupled to blocking oscillator V304B, which drives width multivibrator V310.

3-9. DELAYED SYNC BLOCKING OSCILLATOR V304B

Delayed sync blocking oscillator V304B is a triggered blocking oscillator circuit supplying a sharp positive pulse output from the cathode and a negative pulse output from the plate. Both outputs have repetition rates identical to the output of delay phantastron V309. The delay time of these outputs is determined by the delay phantastron output pulse. The positive pulse output from the cathode of V304B is fed to front panel DELAYED SYNC output receptacle. This positive pulse is coincident with the leading edge of the modulated pulse output.

3-10. WIDTH MULTIVIBRATOR V310

The width circuit of the modulator section consists of a monostable multivibrator using a triode-pentode circuit configuration. The repetition rate is controlled by the repetition rate of the positive driving pulse from the cathode of blocking oscillator V304B. The effective width of the multivibrator output is adjustable between 0.3 and 10 microseconds by PULSE WIDTH MICROSECONDS control C332 on the front panel. Max. Width Adjust R399 sets the maximum pulse width.

3-11. KEYER AMPLIFIER V101 (See figure 4-12.)

Keyer amplifier V101 (in the Tuning Unit) is a transitional stage between the klystron and stages supplying the keying voltage. It is a twin triode which has its cathode pins tied together in all positions of the MODULATION SELECTOR except INT and EXT FM. With no signal applied to the grids of V101, only that half of the tube with plate load resistor R117 conducts and the voltage which appears at its plate, pin 9, is impressed on the grid of the klystron; cutting it off. When negative signals are applied to the grids of V101, the half of the tube that was conducting is cut-off and the other half goes on. The klystron grid cut-off voltage is decreased because no current flows through R117 and the klystron oscillates. The power output and frequency for the pulse duration is the same as that for CW operation, except that a pulse-modulated microwave output is produced. The pulse has the same width and occurs at approximately the same instant as the applied modulating pulse.

When the MODULATION SELECTOR is placed in one of the FM positions, the cathode potential is removed from that half of V101 which supplies the current for R117. The oscillation of the klystron in this instance is controlled by the fm signal which is applied directly to the repeller electrode of the klystron oscillator.

3-12. PROTECTIVE RELAYS (See figure 4-12.)

When POWER ON switch S101 is closed, 115 volts ac is applied to all circuits except the beam power supply and the modulator supply. In order to protect the klystron oscillator tube, thermal time Delay Relay K1 is energized through the normally closed contacts of Holding Relay K2. After a 60-second time delay, contacts 7 and 5 of K1 close, supplying power to the coil of K2, and to the beam and modulator supplies. The energizing of K2 shorts K1 out of the circuit.

3-13. POWER SUPPLIES (See figure 4-12.)

Three electronically regulated power supplies are used in the Model MSG-2P; a modulator, a beam and a repeller power supply. Bridge rectifier, CR1 through CR4, develops -150 volts for the modulator. Series regulator V1, dc amplifier V2 and voltage regulator V3 maintain a regulated voltage output. A constant -108 volts is tapped from this supply to provide voltage for the power monitor bridge. This -150 volt supply, added to -175 volts developed by rectifier V4, series regulator V5 and dc amplifier V6 provides a -325 volt potential to the modulator and the cathode of the klystron oscillator. This -325 volt beam supply supplies the required voltages and currents to the interaction grids of the oscillator tube V13, so that the interaction grids are maintained at a positive potential with respect to the klystron cathode. Since these grids contact the klystron oscillator barrel assembly, it is safer to ground the positive side of the power supply.

The repeller supply consists of rectifier V7, series regulator V8, dc amplifier V9 and voltage regulator V10. The function of the repeller power supply is to furnish a repeller voltage which is always negative with respect to the cathode of the klystron tube. In order to make this repeller voltage negative, the positive side of the repeller power supply is connected to the negative output of the beam power supply. Therefore, though the total output from the repeller supply is 375 volts, the over-all potential to ground is -700 volts.

3-14. FUNCTIONAL OPERATION OF THE THE MECHANICAL COMPONENTS

The principal mechanical components in the signal generator are the oscillator gear box assembly and the thermistor and attenuator drive assemblies. The function of the oscillator gear box is to provide for single control by the R. F. OSC. knob of the klystron choke plunger (operating frequency), of the frequency dial, of the tracking potentiometer (repeller voltage), and of the automatic mode selector (repeller mode of operation). The function of the thermistor and attenuator drive assemblies are to move the thermistor probe (power monitor) and the attenuator probe (power output) inside their respective waveguides. Both assemblies are mounted on a common casting. Movement of the thermistor drive assembly is controlled by the POWER SET knob while movement of the attenuator drive assembly is controlled by the OUTPUT ATTENUATOR knob.

SECTION IV
MAINTENANCE

4-1. GENERAL

A thorough understanding of the theory of operation described in Section III, is necessary before attempting to locate and correct defects. The mechanical drive systems are designed for life-of-equipment operation and should not be tampered with. Unnecessary adjustments of the klystron oscillator and calibrated modulator circuit should not be made, since these may cause loss of accuracy.

4-2. ACCESS TO THE EQUIPMENT

To remove the signal generator from its case, set the equipment face down and loosen the camlocks at each corner of the rear of the dust cover. Slide the case upward.

To gain access to chassis components, proceed as follows:

CAUTION

WHEN SLIDING THE TUNING UNIT OR SUB-ASSEMBLIES OUT OF THE FRAME, BE SURE THAT CABLES ARE CLEAR OF COMPONENTS AND CHASSIS.

a. Modulator Unit -- Remove the machine screws which secure the modulator front panel to the main frame. Remove connectors P3 and P102 from their sockets. Pull the Modulator Unit completely out of the main frame for inspection and testing.

b. Tuning Unit -- Loosen the camlocks located at each corner on the front panel of the Tuning Unit. Pull the unit forward and remove connectors P101 and P102. Withdraw the chassis from the main frame for inspection and testing.

4-3. PRELIMINARY INSPECTION PROCEDURES

Preliminary inspection should be performed on the signal generator, with the equipment de-energized, to correct conditions which might lead to a breakdown. Breakdowns may be caused by an accumulation of dust and dirt on components and parts or by loose connections and fittings. Table 4-1 contains the preliminary inspection procedure.

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. UNLESS ABSOLUTELY NECESSARY, DO NOT SERVICE OR TEST EQUIPMENT WHEN OPERATING POWER IS APPLIED. USE EXTREME CAUTION IN MAKING ALL VOLTAGE CHECKS. REMOVE POWER AND DISCHARGE ALL CAPACITORS BEFORE TOUCHING THEM. DO NOT TOUCH VACUUM TUBES UNTIL THEY HAVE COOLED, OR SEVERE BURNS MAY RESULT.

TABLE 4-1. PRELIMINARY INSPECTION PROCEDURE

Step	What to Inspect	Defects	Remedies	Precautions
1	AC line cord, and video cable.	Kinks in the cable, cuts, deteriorations and fraying of the rubber insulation.	Replace the cable, if necessary.	
		Loose connectors.	Tighten or resolder connections, or replace cable.	
		Dirt, oil, grease, corrosion.	Clean with lint-free cloth moistened with carbon tetrachloride; then wipe dry.	Repeated contact of carbon tetrachloride with skin or prolonged breathing of fumes is dangerous. Make sure adequate ventilation is provided.
2	Power set meter	Bent indicator, cracked or broken glass.	Replace the meter, if necessary.	
3	Knobs, screws, connectors and handles.	Looseness.	Tighten	Tighten carefully, so as not to damage equipment.
4	Switches.	Inability to change positions or evidence of slipping.	Replace all defective switches.	
5	Rear of panel and chassis.	Dirt, corrosion, moisture and rust.	Remove loose dirt and dust with a brush or low air pressure. Remove dirt and grease on the chassis or panel with a brush or cloth dipped in carbon tetrachloride.	See step 1.
6	Mounting screws and clamps.	Looseness.	Tighten.	Do not tighten slotted shafts of variable resistors.
7	Solder joints.	Loose or cold soldered joints and corroded joints.	Resolder, clean and resolder.	
8	Capacitors.	Leaks, bulges and signs of discoloration	Replace capacitor.	
9	Pilot lights.	Jewel cracked, broken or missing, light does not operate.	See that all lamps are operating. Replace burned out lamps. Replace missing, broken or cracked jewel.	

TABLE 4-1. PRELIMINARY INSPECTION PROCEDURE (continued)

Step	What to Inspect	Defects	Remedies	Precautions
10	Tubes, except for reflex klystron.	Poor seating.	Press tubes firmly into sockets.	Never work on tubes immediately after shutdown as serious burns may result. Do not jiggle tubes or partially withdraw them from sockets. Such movements tend to weaken tube pins and spread the contacts in the socket. Do not check the reflex klystron.
11	Tube shields, except for reflex klystron.	Looseness. Missing shields.	Press tube shields firmly into position. Replace missing shields.	
12	Tube sockets.	Looseness Cracks, chips.	Tighten mounting screws. Replace socket, if necessary.	
13	Oscillator drive.	Catching or jamming when R. F. OSC. knob is rotated. Dust, dirt or foreign matter in oscillator gear box or on oscillator drive shaft. Bent or broken teeth on gears.	Clean. Remove all foreign matter. Return to manufacturer or obtain replacement.	Do not drive oscillator in any way other than by its control knob. Do not interfere in any way with the operation of the gear mechanism while the control is being turned. Never use force.
14	Thermistor and attenuator drive assembly.	Catching or jamming	Remove dirt and foreign matter with a brush or line free cloth dipped in carbon tetrachloride.	Same as step 1.
15	Air filter needs cleaning and re-oiling.	Appears dirty or clogged.	Clean with carbon tetrachloride. Dip into a mixture of 1 part SAE No. 30 oil and 3 parts thinner. Shake out and wipe fan blades clean.	Same as step 1.

4-4. TROUBLE SHOOTING

Table 4-2 lists the trouble shooting procedure for localizing a defect to a particular circuit.

NOTE

Do not disturb any preset adjustments unless the trouble is known to be definitely caused by a chassis adjustment control.

As the first step in any trouble shooting, check the power supplies for proper operation. Follow table 4-2 step by step during trouble shooting of the unit. See figures 4-1 through 4-5 for the location of various sub-chassis and tubes. Table 4-3 lists voltages and resistances measured from tube socket terminals to chassis ground.

TABLE 4-2. TROUBLE-SHOOTING CHART

Step	Test Point	Preliminary Action	Normal Indication	If Indication is Abnormal Probable Cause and Remedy
1.	AC power source	Determine proper setting of 115-230 volt switch for available input voltage.	115 or 230 volts ac	Place switch in appropriate position. (See figure 4-3.)
2.	None	Place POWER ON switch to an on position.	Power indicator DS1 lights.	No ac voltage applied to equipment. Open or shorted power cable assembly. Defective switch S101, open fuses F1 or F2.
3.	P101-C	Using a DC voltmeter check power supply voltages to ground.	-150 volts	Check V1, V2 and V3 and associated circuitry.
	P101-B		-108 volts	Check CR105 and R17.
	CATH. TP3		-325 volts	Check V4, V5, V6 and associated circuitry.
	REFL. TP2		-325 to -700 volts	Check V7 through V10 and associated circuitry.
In the following trouble-shooting procedures it is assumed that the power supplies are functioning properly.				
4.	RF OUTPUT front panel connector.	Connect power meter to test point and set up equipment for CW operation. (See paragraph 2-3.)	Meter reads output power	Misalignment of repeller tracking system. (See paragraph 4-9.) If meter gives indication at some points across the band (intermittent power) this indicates a weak klystron V13. If POWER SET meter can not be zeroed, P101 not connected or defective. RT2 defective. M100 defective. ZERO SET potentiometer R203 defective. Coarse Adj potentiometer R17 defective or misadjusted. Defective klystron V13. Note; Check all other trouble symptoms before removing klystron tube from cavity.

TABLE 4-2. TROUBLE-SHOOTING CHART (continued)

In the following modulation trouble shooting conditions, it is assumed that the klystron oscillator is operating satisfactorily in CW. If not, see the above trouble shooting procedure.			
Symptom	Test Point	Normal Indication	If Indication is Abnormal Probable Cause and Remedy
a) No rf pulse available when MODULATION SELECTOR switch is in PULSE position and SYNC SELECTOR switch is in INT position	RF OUTPUT, front panel connector	Rf pulse output	Check modulator tubes: V301, V303, V304, V307 through V310 and associated cricuitry.
b) No rf pulse output available when using external sync.	RF OUTPUT, front panel connector	Synchronized rf pulse output	Check modulator tubes: V305, V306 and associated circuitry.
Unable to vary pulse width when MODULATION SELECTOR switch is in PULSE position	RF OUTPUT, front panel connector	Use of PULSE WIDTH control will vary pulse width.	Check V310, Max. Width Adjust R399 (see paragraph 4-15), PULSE WIDTH C322 and associated circuitry.
a) No rf square wave available when MODULATION SELECTOR switch is in SQ WAVE position and SYNC SELECTOR switch is at INT.	RF OUTPUT, front panel connector	Square wave rf output.	a) Check V301, V302, V305 through V307 and associated circuitry.
b) Poor symmetry in square wave operation			b) Check Symmetry adjust R321 (see paragraph 4-14), R319, and R322.
PRF range can not be covered in internal fm, pulse or square wave operation.	RF OUTPUT, front panel connector	PRF variation from 10 to 10,000 pps.	Check RATE CYCLES/SECOND control R301, Max. Prf Adjust R300 (see paragraph 4-13), V301, and associated circuitry.
DELAY range cannot be obtained in internal and external sync.	RF OUTPUT, front panel connector	DELAY variation from 2 to 2,000 microseconds.	Check Max. Delay Adjust R367 (see paragraph 4-16) DELAY MICROSECONDS R368 control, V308, and associated circuitry.
No delayed sync pulse in internal operation	DELAYED SYNC, front panel connector	Delayed sync output (see paragraph 3-9).	Check C331, R389, V303, V304, V308, V309, and associated circuitry.

TABLE 4-3. VOLTAGE AND RESISTANCE MEASUREMENTS

(TO BE SUPPLIED)

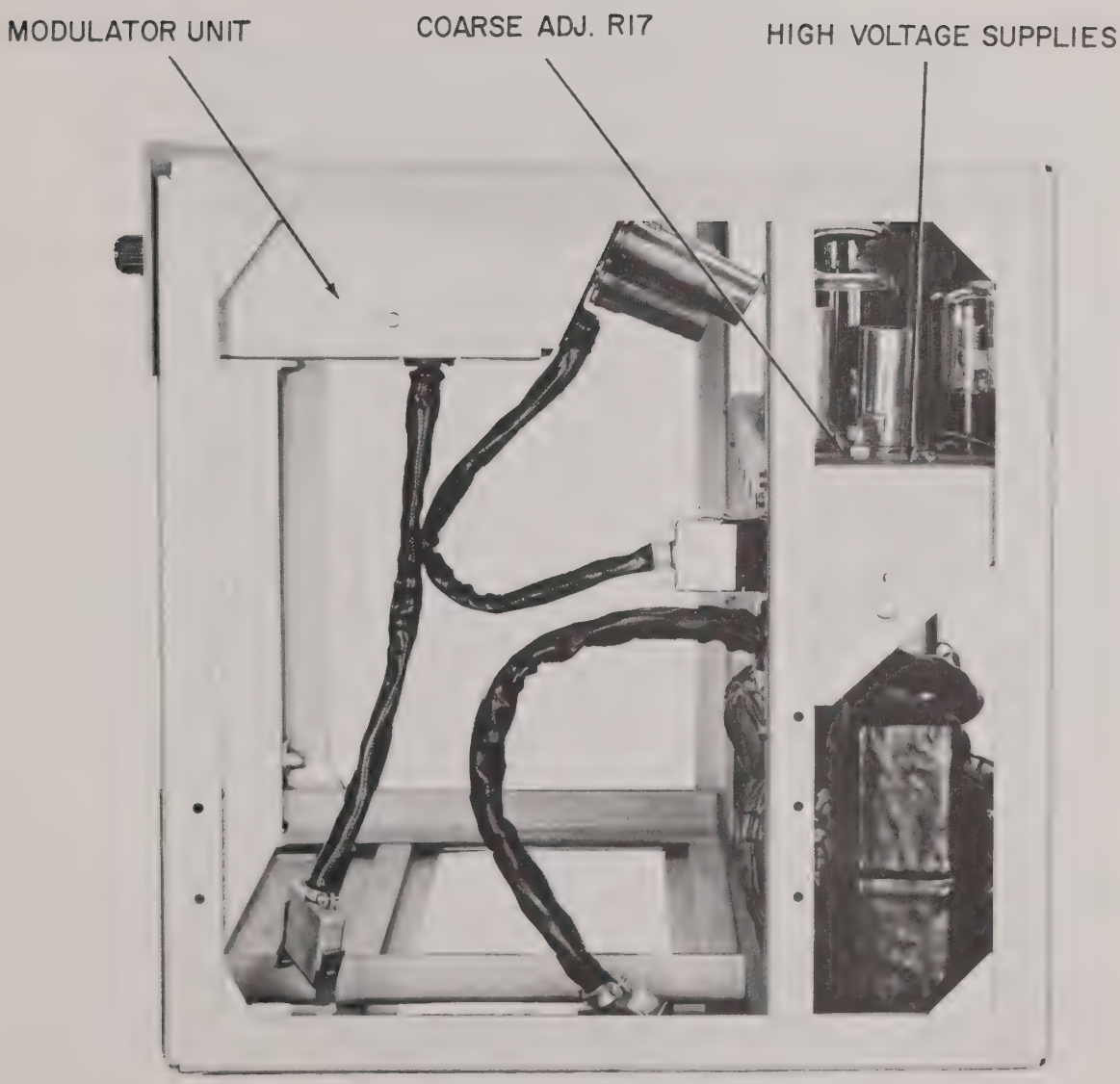


Figure 4-1. Microwave Signal Generator Model MSG-2P, Right Side View.

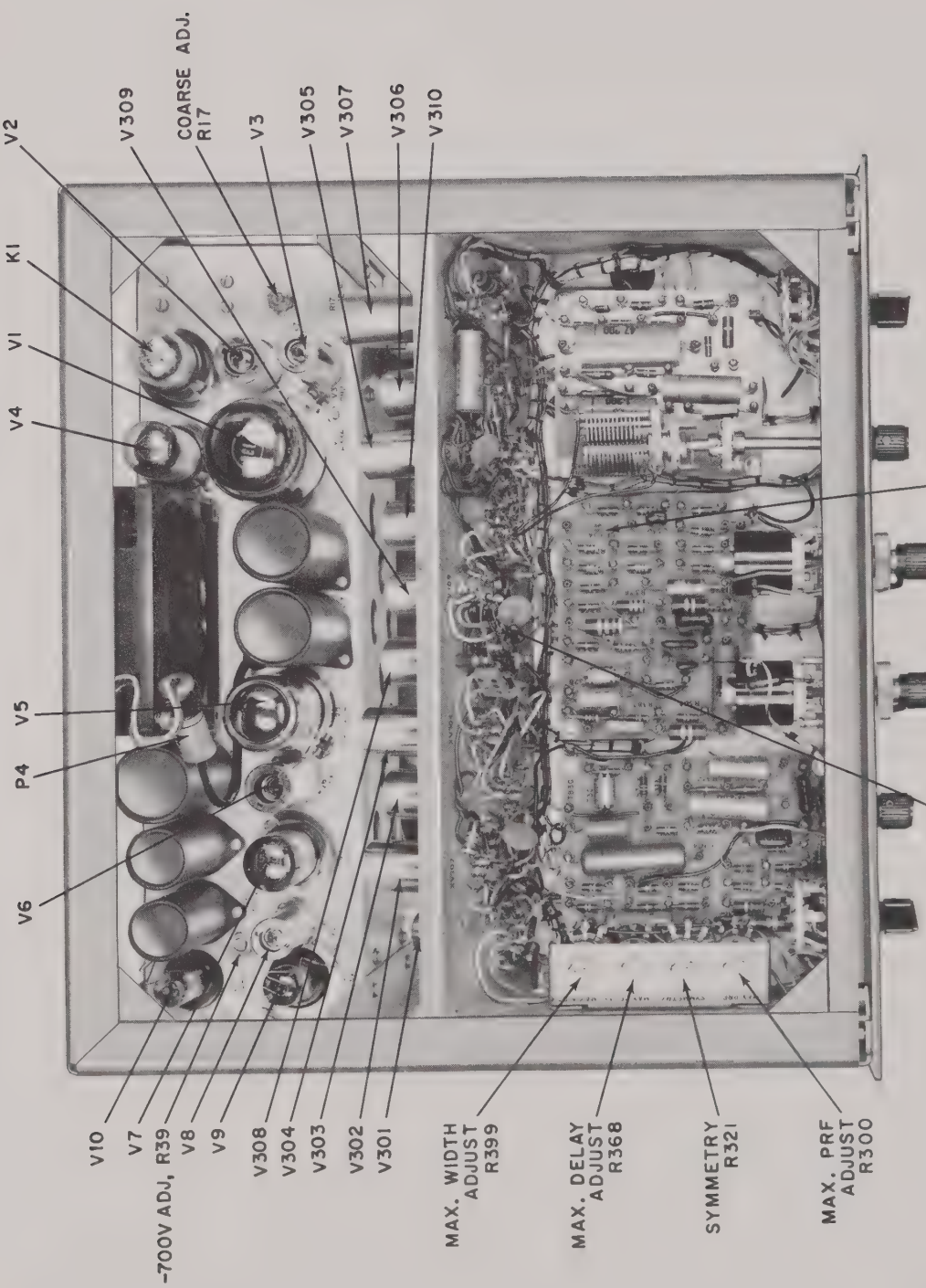


Figure 4-2. Microwave Signal Generator Model MSG-2P, Basic Unit, Top View Showing Modulator Unit.

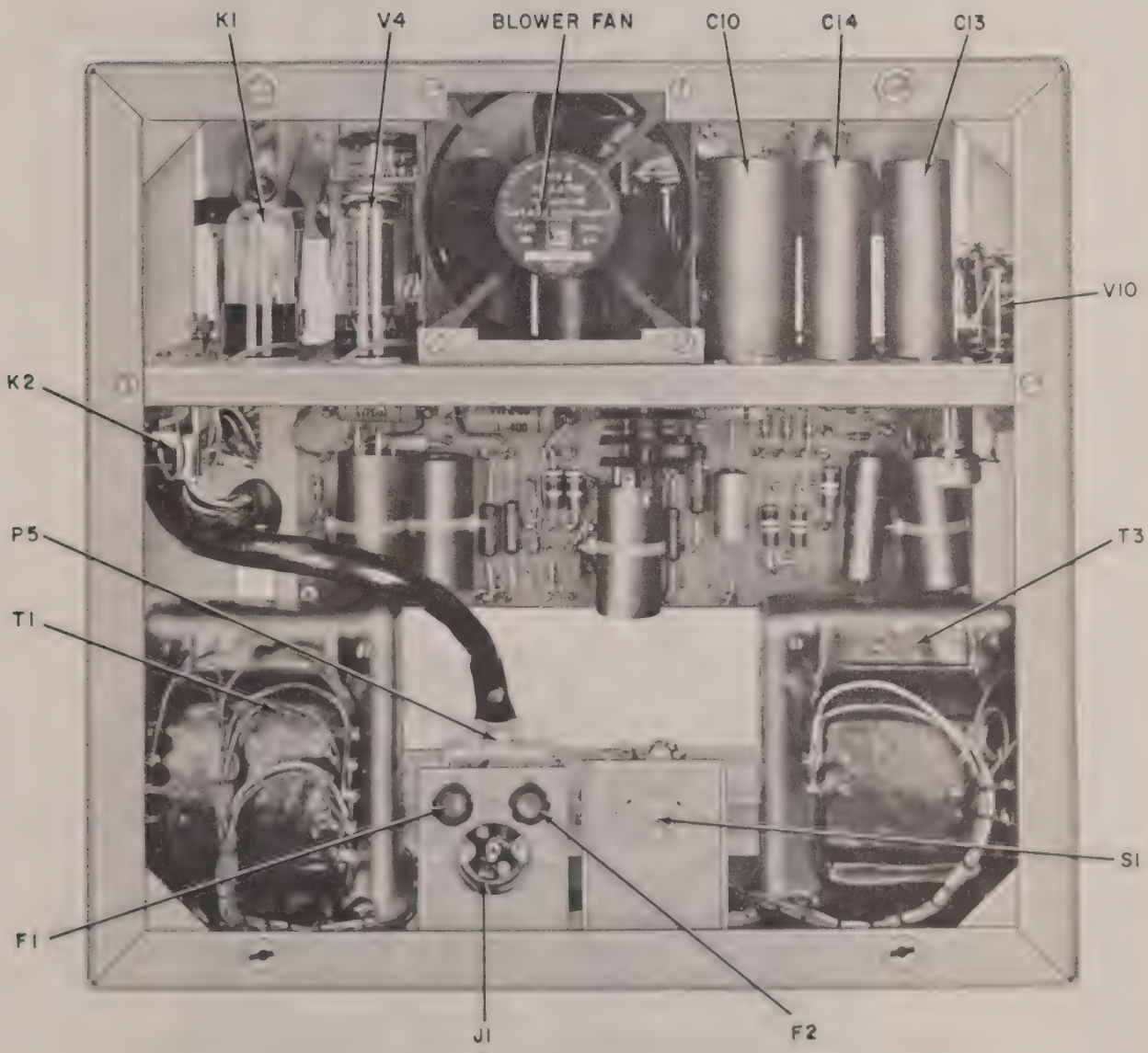


Figure 4-3. Microwave Signal Generator Model MSG-2P, Basic Unit, Rear View.

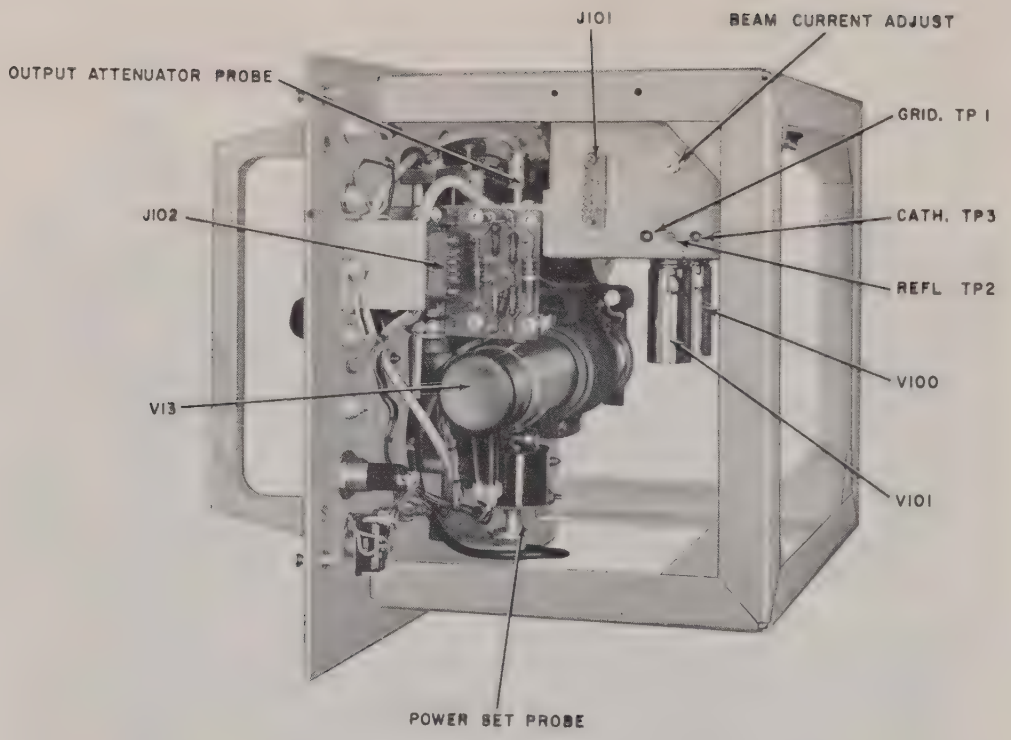


Figure 4-4. Microwave Signal Generator Model MSG-2P, Tuning Unit, Left Rear View.

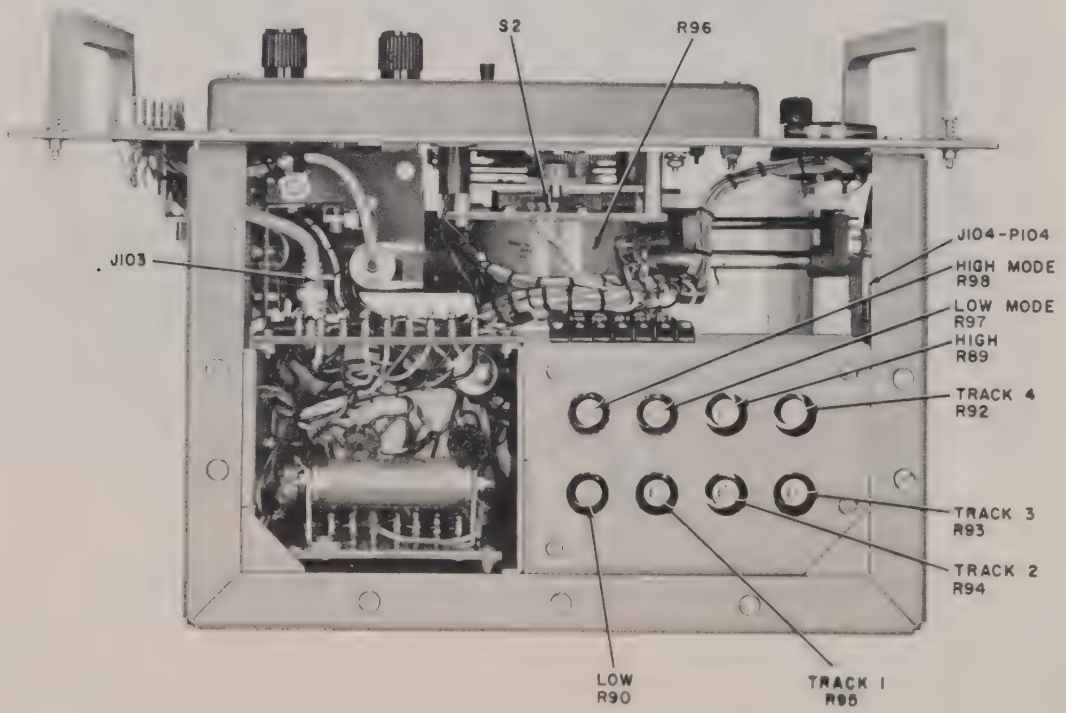


Figure 4-5. Microwave Signal Generator Model MSG-2P, Tuning Unit, Top View.

4-5. REPLACMENT OF RF KLYSTRON OSCILLATOR

(See figure 4-6.)

WARNING

THIS EQUIPMENT EMPLOYS HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. DO NOT ATTEMPT TO REPLACE THE REFLEX KLYSTRON OSCILLATOR TUBE UNLESS THE POWER CORD IS DISCONNECTED FROM THE POWER INPUT RECEPTACLE J1.

a. Removing the Klystron Cover and Klystron Tube

1) Loosen clamp strap around klystron cover.

2) While holding klystron cover in one hand, gently pull the tube socket away from the base of the klystron.

3) Loosen the klystron retainer nut with a spanner wrench. Do not remove the retainer nut completely. A half turn counterclockwise is sufficient to release its locking action.

4) Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction while simultaneously withdrawing the tube from its spring-finger holder within the cavity.

5) Carefully insert a replacement tube into the cavity. Gently push the new tube into the center of the cavity and press all the way in against a noticeable resistance. Continue pushing the tube into the cavity, giving the tube a slight clockwise twist until it meets a positive stop.

6) Use the spanner wrench to tighten the klystron retainer nut.

b. Reassembling the klystron Cover.

1) Attach the tube socket to the base of the klystron tube. Be sure that the proper tube socket pins are engaged, since this miniature socket may be easily forced into an improper position which will result in the application of improper voltages to the klystron tube.

2) Slide the klystron cover over the socket until the klystron retainer nut is covered. Tighten clamping strap to secure the shield.

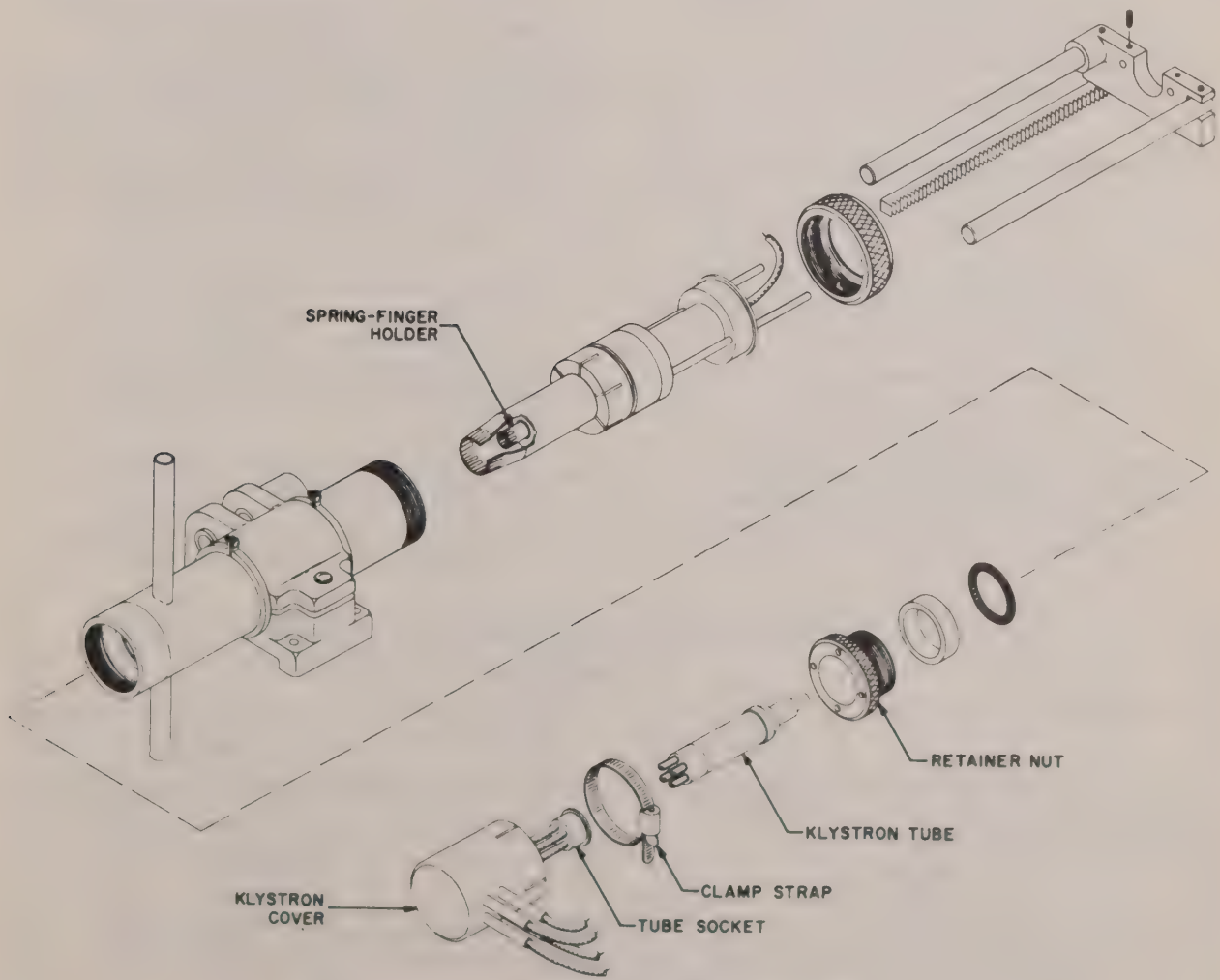


Figure 4-6. Oscillator Cavity, Exploded View.

3) After replacing the klystron oscillator tube, certain adjustment and alignment procedures must be performed. See paragraph 4-7 for the adjustment of Beam Current Adj R111, paragraph 4-9 for the repeller voltage tracking adjustment and alignment and paragraph 4-11 for the frequency dial calibration.

4-6. REPELLER POWER SUPPLY ADJUSTMENT

Due to replacement or aging of tubes in the repeller power supply it may become necessary to re-adjust the supply. This is accomplished as follows:

1) Remove the Tuning Unit from the signal generator.

2) Connect the negative lead of a DC Voltmeter to pin E of P101. Connect the positive voltmeter lead to ground.

3) Turn on the equipment.

4) If necessary, adjust -700 V Adj. R39 for a -700 volt indication on the meter.

5) Turn off the equipment before removing the voltmeter leads.

4-7. BEAM CURRENT ADJUSTMENT

To adjust the beam current proceed as follows:

1) Remove the signal generator from its case.

2) Connect the leads of a voltmeter to test points GRID. TP1(+) and CATH. TP3(-).

3) Turn the POWER ON switch to an on position and allow a one minute time delay.

4) With the MODULATION SELECTOR at CW, rotate Beam Current Adjust R111 until the voltmeter reads +10 volts. (Approximately -10 volts should be obtained upon switching to ZERO SET.)

5) Turn the POWER ON switch off and remove the voltmeter leads.

4-8. 115-230 VOLT SWITCHING SYSTEM

The 115-230 volt input switch S1 at the rear of the equipment is normally factory set at 115 volts. If it is desired to use a 230 volt input, S2 must be reset. Remove the dust cover by setting the equipment on its face and loosening the camlocks located at each corner of the rear of the cover. Slide the case upward. Simply place the switch in the desired position.(See figure 4-3.)

4-9. REPELLER VOLTAGE TRACKING PROCEDURE

Due to variations in klystron tube characteristics, replacement of this tube will usually require readjustment of the repeller tracking voltages. The repeller voltage tracking procedure assumes that the unit was previously aligned and operating, but that the klystron was changed. The repeller voltages are first adjusted for proper mode trace on the oscilloscope in CW operation, and then in pulse modulated output. The equipment needed to perform the above is listed in table 4-4. The test setup described below permits the display of the klystron oscillator repeller modes on the oscilloscope screen, while using the internal sawtooth sweep from the equipment as the horizontal time base line.

1) Loosen the four front panel camlocks retaining the Tuning Unit and partially withdraw it from the main frame. PROCEED WITH CAUTION. Set up the equipment as shown in figure 4-7 while operating power is disconnected.

2) See table 4-4 for the equipment required at the different frequency ranges.

3) Connect one end of the coaxial crystal mount, with dc return, to the vertical input of a high

TABLE 4-4. TEST EQUIPMENT REQUIRED FOR REPELLER TRACKING PROCEDURE

Frequency Range	Oscilloscope	Coaxial Crystal Mount	Reaction Type Frequency Meter Accuracy of 0.1% or Better	Coaxial to Waveguide Adapter	Voltmeter (20,000 ohms/volt)
2.15 to 2.6 kmc	Dumont 304A for external fm operation or Tektronix 531A for internal pulse modulation	PRD-612A	PRD-579A	None	Simpson 250
2.6 to 3.95 kmc			DeMornay-Bonardi DBL-715-1	DeMornay-Bonardi DBL-057	
3.95 to 4.6 kmc			PRD-532	PRD-357	

gain oscilloscope and the opposite end via a coaxial-to-waveguide adapter to a reaction type frequency meter having an accuracy of 0.1% or better.

4) Connect a coaxial-to-waveguide adapter between the signal generator output and the reaction type frequency meter.

5) Connect a test lead to the repeller connection at test point REFL. TP2, located at side of keyer chassis.

6) Connect the opposite end of the test lead, via a one-microfarad dc blocking capacitor rated at 1,000 VDCW or greater, to the horizontal plate input of the oscilloscope.

7) Connect a common ground lead between the signal generator and the oscilloscope.

8) With the MODULATION SELECTOR at CW, apply operating power to the signal generator and allow at least a 20-minute warm-up period.

9) Rotate the SYNC SELECTOR to its INT position.

10) Set the RATE CYCLES/SECOND control to produce any desired sweep rate within the range from 10 to 10,000 sweeps per second.

11) Rotate the MODULATION SELECTOR to its INT FM position to obtain a frequency-modulated rf output test signal. A typical mode pattern is shown in figure 4-8.

12) Adjust the POWER SET control to maintain the POWER SET meter indicator on scale.

13) Connect the negative lead of a 20,000-ohm-per-volt meter to repeller connection REFL. TP2, and the positive lead to cathode connection CATH. TP3. Then proceed as follows:

Step	Set Frequency Dial to (in megacycles)	Indication		If indication is not correct, adjust:
		Voltage* (Volts)	Mode	
1	2900(-)	330	At center of trace	Low Mode - R97
2	2150	170	At center of trace	Low - R90
3	2900(+)	125	At center of trace	High Mode -R98
4	4600	330	At center of trace	High -R89
(+) indicates slightly greater than (-) indicates slightly less than				
Recheck the repeller voltages at the high and low dial frequencies by repeating steps 1 through 4 above. If the klystron has been replaced, the above procedure should afford correct repeller tracking. Failure to track properly may indicate a defective replacement klystron. Check the intermediate tracking points by proceeding as directed below.				
5	2250	189	At center of trace	Track 1 - R95
6	2600	275	At center of trace	Track 2 - R94
7	3100	140	At center of trace	Track 3 - R93
8	3700	215	At center of trace	Track 4 - R92
*Approximate. There may be a variation of ±10% due to differences in klystron tubes.				

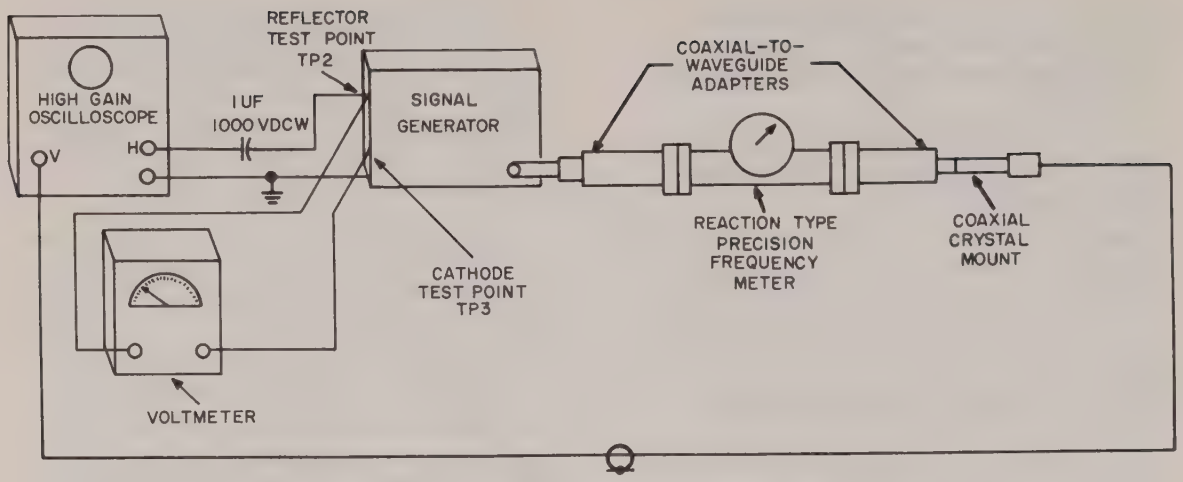


Figure 4-7. Repeller Voltage Tracking, Test Set-Up.

NOTE

Track 2, R94, should not be readjusted unless adjustment of Low Mode potentiometer R97 cannot obtain the required indications.

14) The repeller voltages must now be rechecked, as directed above, because of the interacting effects of the adjustments. Minor adjustments should be made, as necessary, to complete the alignment procedure.

15) The repeller voltage tracking should be checked throughout the tuning range of the equipment. Proceed as follows:

a) Rotate the MODULATION SELECTOR to its PULSE position.

b) Set the SYNC SELECTOR to its INT position.

c) Set the RATE CYCLES/SECOND control to produce a pulse repetition frequency of approximately 1,000 pps.

d) Perform the complete test outlined in steps 1) through 14) above with the signal generator this time producing a pulse-modulated output. Readjust any of the Track controls, if necessary, in order to obtain the best possible tracking in cw and pulse-modulated outputs.

4-10. TRACKING ADJUSTMENT AFTER REPLACEMENT OF A TRACK POTENTIOMETER

After replacement of one of the track potentiometers R89, R90, R92 through R98, set the arm of the new potentiometer to the center of its travel and proceed as directed in paragraph 4-9.

NOTE

If trouble is experienced in the alignment of the repeller tracking circuit, it may be localized to an incorrect repeller voltage supply by measuring the voltage as described in table 4-2.

4-11. FREQUENCY DIAL CALIBRARATION

When the klystron tube has been replaced, the following procedure should be performed.

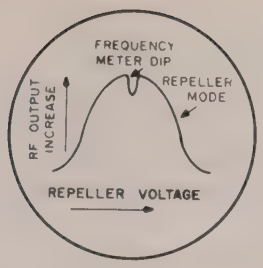
1) Connect the test setup and equipment as described in paragraph 4-9, using the proper reaction type frequency meter to check the low-end frequency. Set the signal generator frequency dial to 2,150 mc and tune the frequency meter for a dip (or wiggle) at the center of the mode trace. Note the frequency meter setting.

2) Remove the frequency meter and substitute another meter to measure the high-end frequency. Set the signal generator to 4,600 mc and tune the frequency meter for a dip at the center of the mode trace. Note the frequency meter setting.

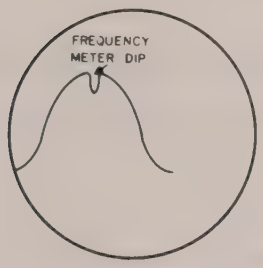
3) Check the frequency meter settings noted in 1 and 2 above. They should be ±1 per cent of the end frequencies. No frequency correction is necessary if the generator output signals fall within these limits. If a frequency correction is necessary, reset the frequency dial as described below.

4-12. FREQUENCY DIAL CORRECTION

If the frequency dial reading differs from the actual



MODE PATTERN CENTERED



MODE PATTERN NOT CENTERED

PHASE SHIFT CONTROL IMPROPERLY ADJUSTED

Figure 4-8. Typical Mode Pattern.

frequency output by more than ±1 per cent, proceed as follows:

1) Draw a line on the main front panel directly up from the hairline.

2) Remove the dial cover.

3) Set the MODULATION SELECTOR to CW. Turn power on and allow twenty minutes for the signal generator to warm up.

CAUTION

ADJUST POWER SET CONTROL TO PREVENT THE POWER SET METER NEEDLE FROM GOING OFF SCALE.

4) Set the frequency meter to the high-end frequency and tune the signal generator until a dip appears at the center of the mode trace. Lock the dial with the dial lock.

5) Loosen the three screws holding the frequency dial to the hub. Using the pencil line as a hairline, reset the frequency dial to correct the frequency error and tighten the three screws.

6) Recheck the dial calibration.

7) Replace the dial cover and recheck the dial calibration.

4-13. SETTING MAXIMUM PRF ADJUST R300

The following procedure should be performed when V301, V303, V304 or their associated components have been replaced.

1) Connect the signal generator and test equipment as shown in figure 4-9. Energize the equipment and allow a twenty minute warm-up period.

2) Set the Rate Multiplier control to X100. Set the RATE CYCLES/SECOND control to 100. Set the MODULATION SELECTOR switch to PULSE and the SYNC SELECTOR switch to INT.

3) Check for a 10,000 cps pulse repetition rate. If the pulse repetition rate does not fall on 10,000 cps, then adjust Max. PRF Adjust R300. The low end of the repetition rate range will now automatically fall in and track correctly.

4-14. SETTING SYMMETRY ADJUST R321

The following procedure should be performed when V302 or any of its associated components are changed.

1) Connect the signal generator and test equipment as shown in figure 4-10.

2) Set the RATE MULTIPLIER control to X100. Set the RATE CYCLES/SECOND control to 100. Set the MODULATION SELECTOR switch to SQ WAVE and the SYNC SELECTOR switch to INT.

3) Using a Hewlett-Packard 420A coaxial crystal detector having a 250-ohm termination, feed the detected rf output signal to the vertical input of the Tektronix Model 531 oscilloscope.

4) Adjust Symmetry adjust R321 until the pulse width of the waveform displayed on the oscilloscope is 50 per cent of the repetition rate or until the "on" and "off" periods are equal.

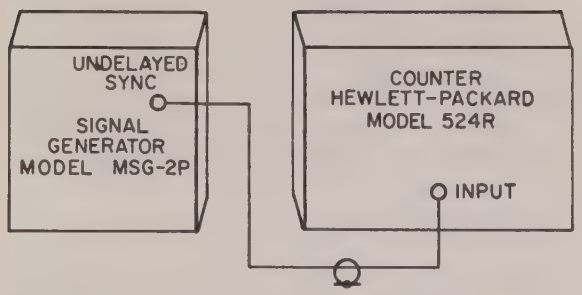


Figure 4-9. Test Set-up For Maximum PRF Adjust R300

5) Lock the shaft of R321 in the desired position by tightening the locknuts. Recheck the symmetry of the square wave.

4-15. SETTING MAXIMUM WIDTH ADJUST R399

The following procedure should be performed when V310 or any of its associated components are changed.

1) Connect the signal generator and test equipment as shown in figure 4-10.

2) Set the signal generator for internal pulse operation. Set the PULSE WIDTH control to 10 microseconds.

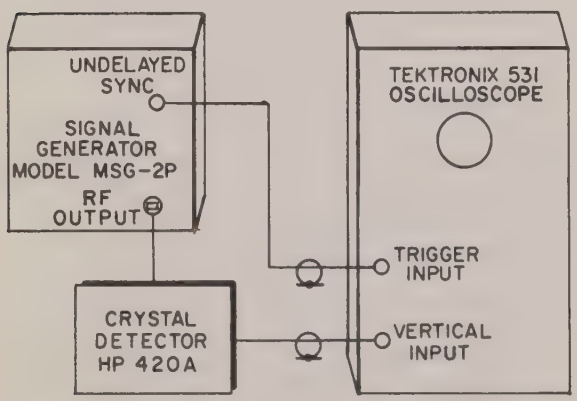


Figure 4-10. Test Set-up For Symmetry Adjust R321 and Maximum Width Adjust R399.

3) Couple the rf output of the equipment to the vertical input of the Tektronix Model 531 oscilloscope through the Hewlett-Packard 420A coaxial crystal detector having a 250 ohm termination.

4) Adjust Max. Width Adjust R399 for a 10 microseconds pulse width. Lock the potentiometer shaft lock in the desired position. Recheck the pulse width after the lock has been tightened.

4-16. SETTING MAXIMUM DELAY ADJUST R367

The following procedure should be performed when V308, V309, or any of their associated components are changed.

1) Connect the signal generator and test equipment as shown in figure 4-11.

2) Set the SYNC SELECTOR switch to INT and the Delay Multiplier to X100. Set DELAY MICROSECONDS to 20.

3) Adjust Max. Delay Adjust R367 for 2000 microseconds spacing between the undelayed and delayed triggers. Lock the shaft in the desired position by tightening the locknut. Recheck the spacing after the locknut has been secured.

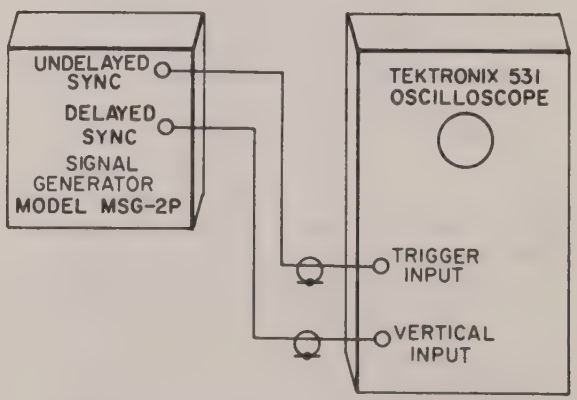
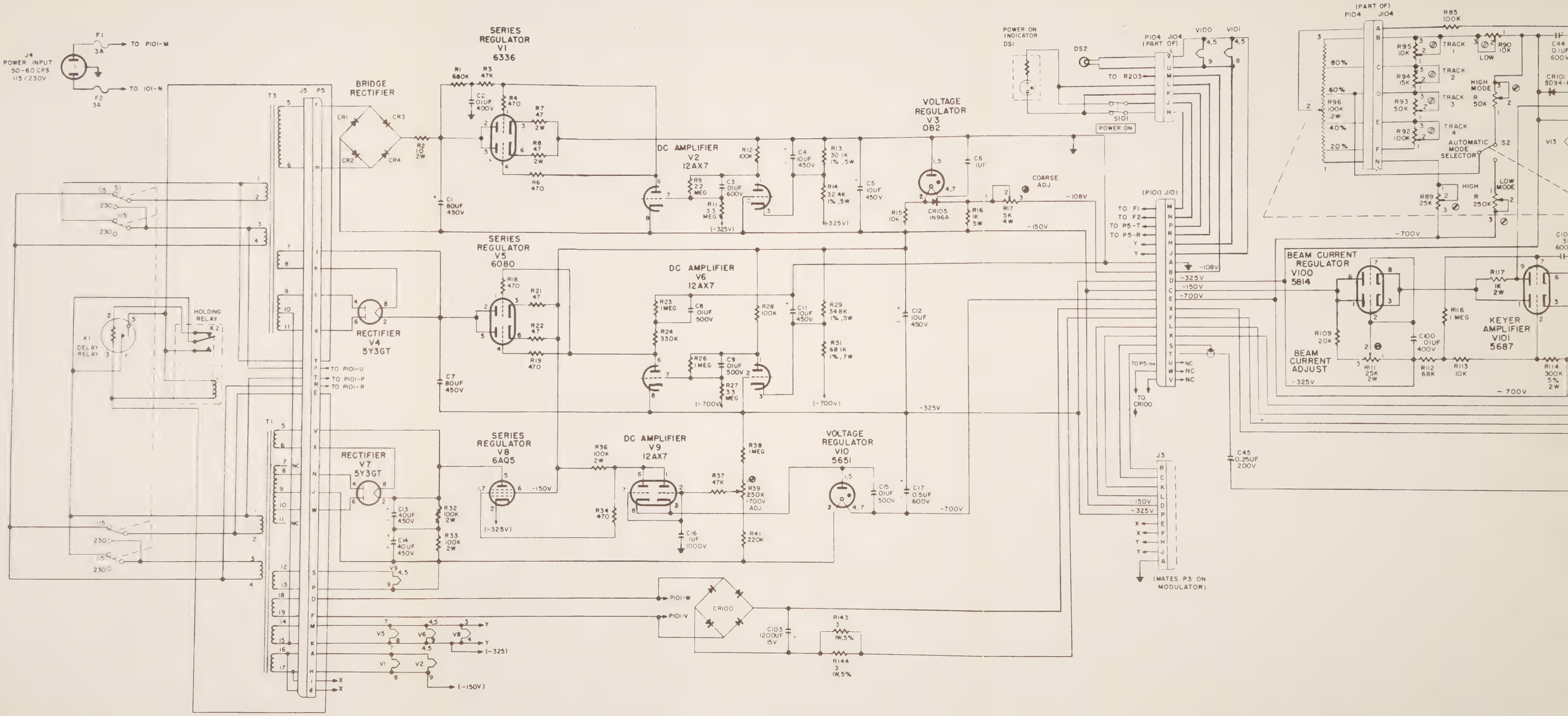
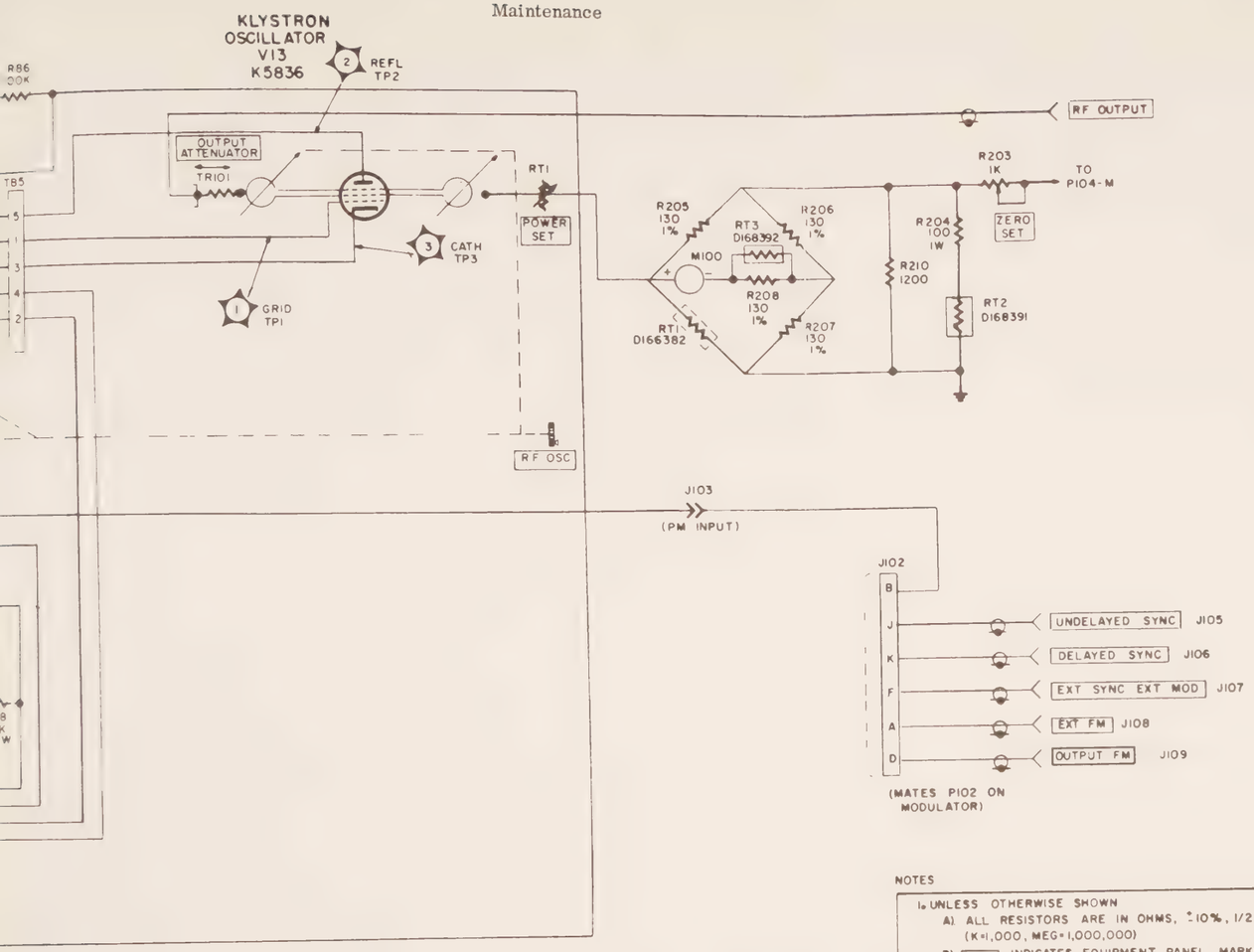


Figure 4-11. Test Set-up For Maximum Delay Adjust R367.


J4
POWER INPUT
50-60 CPS
115/230V
F1
3A
F2
3A
TO P101-M
TO 101-N
T3
T1
J5
P5
BRIDGE
RECTIFIER
CR1
CR2
CR3
CR4
R2
10
2W
C1
80UF
450V
SERIES
REGULATOR
V1
6336
R1
680K
R3
47K
C2
01UF
400V
R4
470
R7
47
2W
R8
47
2W
R6
470
DC AMPLIFIER
V2
12AX7
R12
100K
C4
10UF
450V
R13
30 1K
1%,5W
R14
32 4K
1%,5W
C5
10UF
450V
R9
2 2
MEG
C3
01UF
600V
R11
3 3
MEG
(-325V)
(+325V)
VOLTAGE
REGULATOR
V3
0B2
C6
1UF
CR105
1N96A
R15
10K
R16
1K
5W
R17
5K
4W
COARSE
ADJ
-108V
-150V
-325V
-700V
SERIES
REGULATOR
V5
6080
R18
470
R21
47
R22
47
R19
470
C7
80UF
450V
DC AMPLIFIER
V6
12AX7
R23
1MEG
R24
330K
C8
01UF
500V
R26
1MEG
C9
01UF
500V
R27
3 3
MEG
R28
100K
C11
10UF
450V
R29
34 8K
1%,5W
R31
68 1K
1%,7W
C12
10UF
450V
(-700V)
RECTIFIER
V4
5Y3GT
TO P101-U
TO P101-P
TO P101-R
RECTIFIER
V7
5Y3GT
C13
40UF
450V
C14
40UF
450V
R32
100K
2W
R33
100K
2W
SERIES
REGULATOR
V8
6AQ5
-150V
(-325V)
DC AMPLIFIER
V9
12AX7
R36
100K
2W
R34
470
R37
47K
R38
1MEG
R39
250K
-700V
ADJ
R41
220K
C16
1UF
1000V
VOLTAGE
REGULATOR
V10
5651
C15
01UF
500V
C17
0 5UF
600V
C45
0.25UF
200V
CR100
C103
12000UF
15V
R143
3
1W,5%
R144
3
1W,5%
P101-W
P101-V
POWER ON
INDICATOR
DS1
DS2
TO R203
S101
POWER ON
P104
(PART OF)
J104
V100
V101
(P101) J101
TO F1
TO F2
TO P5-T
TO P5-R
TO P5-n
TO
CR100
NC
NC
NC
J3
(MATES P3 ON
MODULATOR)
(PART OF)
P104
J104
R85
100K
R95
10K
TRACK
1
R94
15K
TRACK
2
R93
50K
TRACK
3
R92
100K
TRACK
4
R90
10K
LOW
HIGH
MODE
R
50K
AUTOMATIC
MODE
SELECTOR
S2
80%
60%
40%
20%
R96
100K
2W
HIGH
MODE
R89
25K
LOW
MODE
R
250K
-700V
BEAM CURRENT
REGULATOR
V100
5814
R117
1K
2W
R116
1MEG
KEYER
AMPLIFIER
V101
5687
R109
20K
BEAM
CURRENT
ADJUST
-325V
R111
25K
2W
C100
01UF
400V
R112
68K
R113
10K
R114
300K
5%
2W
-700V
C44
0.1UF
600V
CR101
SD94-A
V13



NOTES

1. UNLESS OTHERWISE SHOWN
   A) ALL RESISTORS ARE IN OHMS, ±10%, 1/2 WATT. (K=1,000, MEG=1,000,000)
   B) ▭ INDICATES EQUIPMENT PANEL MARKING
   C) ⊘ INDICATES SCREWDRIVER ADJUSTMENT
   D) ◯ INDICATES MAJOR TEST POINT

Figure 4-12. Microwave Signal Generator Model MSG-2P, Overall Schematic Diagram, Less Modulator.

RATE PHANTASTRON FM GENERATOR V301 5725

CATHODE FOLLOWER V302A 1/2 6U8

SQUARE WAVE GENERATOR V302B 1/2 6U8

PULLER AMPLIFIER V303A 1/2 12AU7

PHASE INVERTER V305A 1/2 6U8

CLIPPER AMPLIFIER V305B 1/2 6U8

SCHMITT TRIGGER V306 5687

CATHODE FOLLOWER V308A 1/2 12AU7

DELAY PHANTASTRON V309 5725

BUFFER AMPLIFIER V308B 1/2 12AU7

PULLER AMPLIFIER V303B 1/2 12AU7

DELAYED SYNC BLOCKING OSCILLATOR V304B 1/2 5687

P102
FM OUTPUT
UNDELAYED SYNC
EXT FM
PULSE MODULATED OUTPUT
EXT SYNC EXT MOD
DELAYED SYNC
NC
NC
NC
(MATES J102 ON TUNING UNIT)

SYNC SELECTOR

MAX. PRF ADJ.

RATE CYCLES/SECOND

S302 RATE MULTIPLIER X1 X10 X100

SYMMETRY

FM AMPLITUDE

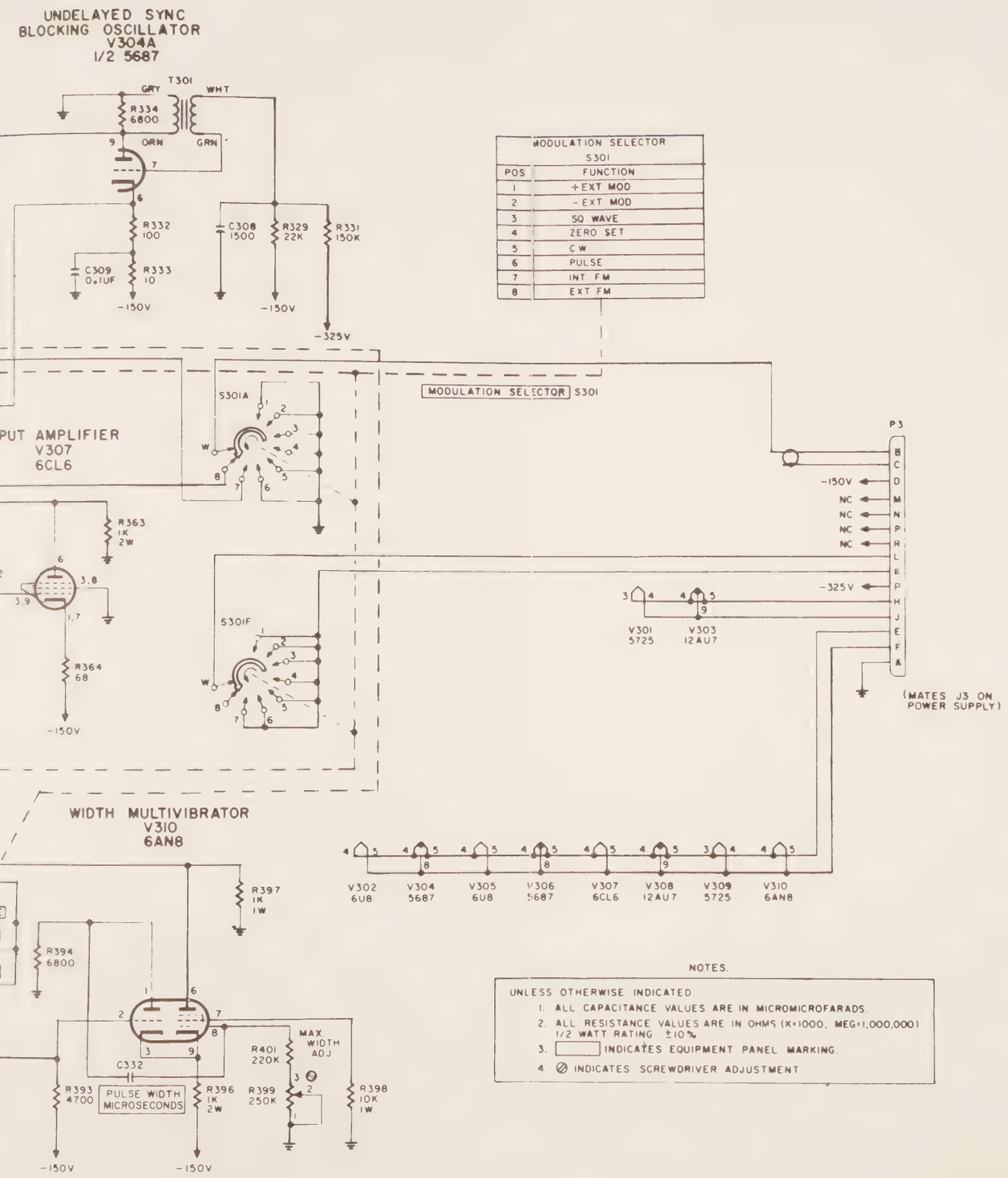
MAX. DELAY ADJ.

DELAY MICROSECONDS

S303 DELAY MULTIPLIER

T302 GRY WHT ORN GRN

H111827



NOTES.

UNLESS OTHERWISE INDICATED

1. ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
2. ALL RESISTANCE VALUES ARE IN OHMS (K=1000, MEG=1,000,000) 1/2 WATT RATING ±10%
3. ☐ INDICATES EQUIPMENT PANEL MARKING.
4. ⊘ INDICATES SCREWDRIVER ADJUSTMENT

Figure 4-13. Microwave Signal Generator Model MSG-2P, Modulator Unit, Schematic Diagram.

SECTION V
PARTS LIST

(TO BE SUPPLIED)

POLARAD ELECTRONICS CORP.

CONSULTANTS — DESIGNERS — MANUFACTURERS

43-20 34th Street Long Island City 1, N. Y.

EXeter 2-4500

REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____ DATE: _____

ADDRESS: _____ INDIVIDUAL _____

_____ POSITION _____

SECTION OR DIVISION _____ PHONE NO. _____ EXT. _____

EQUIPMENT _____ DATE OF PURCHASE _____

MODEL _____ SERIAL NO. _____ ORDER NO. _____

TROUBLE REPORT:

A. Description of trouble _____

_____

_____

_____

_____

_____

B. Has trouble been localized? _____ If so, how and where: _____

_____

_____

_____

_____

_____

C. Instruments used and measurements taken, if any: _____

_____

_____

_____

D. Is trouble intermittent? _____

E. Hours of operation prior to this trouble _____

F. Date trouble occurred _____

G. Was factory consulted by telephone or letter prior to this request? _____

If so, give date and person to whom directed: _____

_____

H. Additional Comments: _____

_____

_____

_____

_____

_____

_____

When trouble develops requiring factory assistance, complete this form and send to:

Polarad Electronics Corporation
43-20 34th Street
Long Island City 1, New York
ATTENTION: Service Department

After this report has been analyzed by the Service Department, you will be notified when a field service engineer will call on you to make the necessary repairs. If your trouble can best be corrected at the factory, we will so notify you with instructions and authorization for returning the equipment.

NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION

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POLARAD ELECTRONICS CORPORATION

43-20 34th Street
Long Island City 1, New York

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MICROWAVE RECEIVERS & FIELD INTENSITY METERS, 0.4—84.2 KMC

Polarad, pioneer in microwave receiver development, offers the industry's most complete and diversified line of precisely-calibrated, wide-range receivers and radio-interference-and-field-intensity(RI/FI)meters. The new transistorized portables feature built-in inverters for optional 12 VDC operation. **Only Polarad** offers **both** calibration techniques: Integral signal generator (Model FIM-2) for wide-range, absolute level calibration **or** (Model CFI) integral impulse generator for simplicity, convenience. All units have audio, video, and recorder outputs. All display output directly in db.

Model CFI Portable Transistorized Calibrated RI/FI — Meter/Receiver

Model R Wide-Range Multipurpose Microwave Receiver

Model FIM-2 Absolute-Calibrated RI/FI—Meter/Receiver

Model TR Transistorized Portable Wide-Range Multipurpose Receiver

Both the CFI and FIM-2 have Category A Air-Force Approval Per MIL-I-26600 and MIL-I-6181

MODEL	DESCRIPTION	FREQUENCY RANGE	MINIMUM SENSITIVITY ⑥	SELECTIVITY & TUNING (see notes below)	CHARACTERISTICS
CFI	TRANSISTORIZED CALIBRATED RI/FI METER/RECEIVER (Category A AF approved)	1-10 KMC (0.95-11.26 as receiver)	—90 to —84 dbm	① ② ③ ④	• **Digital** frequency dial • AM, FM, CW, Pulse reception • AFC, AGC (60 db linearity range!) • Calibrated antenna system includes both omni (broad-band) and directionals for each range. • Attenuation: 0-80 db in 1 db steps • Front panel metering of average, peak, slide-back peak, or quasi-peak RF level.
FIM-2	CALIBRATED RI/FI METER/RECEIVER (Category A AF approved)	1-10 KMC Check Polarad for 21 KMC Coverage.	—81 dbm	① ② ③ ④	• Single UNIDIAL® tunes both receiver and signal generator. • First system to determine radiated RF interference and susceptibility.
TR	TRANSISTORIZED MICROWAVE RECEIVER	0.95-11.26 KMC	—90 dbm	① ③ ④ ⑤	• AFC, AGC circuits. • **Digital** frequency dial • AFC, AGC (60 db linearity range!) These versatile precision devices are really **four instruments in one:** • AM, FM, CW, MCW, Pulse Receiver. • Field-intensity receiver. • Pulse, pulse-time position demodulator. • Sensitive power meter.
R	ULTRA-WIDE-BAND MICROWAVE RECEIVER	0.4-84.2 KMC	—85 to —50 dbm	② ③ ⑤	• UNIDIAL® direct-reading freq. control • AFC, AGC (60 db linearity range!)

① Impulse Bandwidth: 1, 5, or 8 mc (Model FIM-2, 5MC only).
② Image and Spurious Response Rejection: better than 60 db. (up to 11.26 KMC in Model R)
③ Four plug-in tuning units cover entire range (Model R uses 9) and all are direct-reading, calibrated to ±1%.
④ Maximum RF input, 3 Volts.
⑤ Video bandwidth: 3.5 MC (Model TR) 2 MC (Model R)
⑥ Depending upon frequency.

ANTENNA PATTERN TUNING UNIT 2-75 KMC: Used with Model R receiver. External Mixer with flexible cable. Locate up to 75 ft. from receiver, at or near antenna. Internal 1 KC sweep — compatible with all standard AC recorders.

Model RW-T

CALIBRATED ANTENNAS
1,000 to 10,000 MC

TEST ANTENNAS
1,000 to 40,000 MC

TRANSISTORIZED IMPULSE GENERATOR Model IC-120: 1 MC-10 KMC. Calibrates microwave receivers for RI/FI work. Signal source for spectrum analyzers. Generates 0.02 nanosec. pulses.

ALL-CERAMIC REFLEX KLYSTRONS Maximum resistance to shock, vibration, temperature extremes. Guaranteed operation to 250°C, without cooling. Stable, low noise, low microphonics. (X series has guaranteed minimum 200 mw output.) Request complete application data.

TYPE	FREQ. RANGE—KMC	RETMA
ZV1012	0.5 - 3.0	7506
ZV1010	0.7 - 3.0	7505
ZV1010X	0.95- 2.8	——
ZV1021	1.0 - 4.0	——
ZV1021X	1.0 - 4.0	——
ZV1009	1.5 - 6.0	7049
ZV1009X	1.7 - 5.0	——
ZV1011	4.0 -11.0	8052

SPECIAL INSTRUMENTATION for MICROWAVE DEVELOPMENT, PRODUCTION, CHECKOUT.

Condensed listing of precision instruments developed by Polarad to meet a wide range of requirements.

Model MP-1A
Five-Channel Coded Multipulse Generator

CODED MULTI-PULSE GENERATOR. Model MP-1A. Five independently adjustable channels generate coded multipulse trains. Permits independent external PTM of each channel. 10-10,000 cps group rep-rate, each pulse adj. 0.2-2 μsec. Delay, 0-300 μsec.

PULSE JITTER TESTER. Model PJ-1. Measures and displays magnitude and waveform of:
Relative jitter: 5/10/100 nanosec. full scale
Pulse-width jitter: 5/10/100 nanosec. full scale
Rep-rate jitter: 5/10/100 nanosec, 1/10/100 μsec. full scale

MICROWAVE TUBE TESTER. Model K-200. Simple as conventional tube tester, monitors cathode, anode, grid, reflector voltages and currents, checks shorts, fil. continuity. Tests klystrons (internal/external-cavity) pencil triodes, rocket and lighthouse tubes.

PRECISION NOISE GENERATOR. Model N-1. 1KC-500MC source for direct measurement of noise figure (1-20 db, accurate to ±0.25 db) of VT and transistor circuits.

TRANSISTORIZED MICROWAVE POWER METER. Model P-3. Measures absolute power instantly, directly, 10-40,000 MC with 5 interchangeable thermistor mounts. 0.01 MW full scale sensitivity! Line or battery operated, only 6 lbs.

BG-6789

I would like more information and specifications on: (circle)

SPECTRUM ANALYZERS
TSA SA-84 DA-70
TSA-S SA-84T WSA
TSA-W SA-84W SD-1

SIGNAL GENERATORS
PMR MSG-1R EHF
MSG-34 MSG-2R KSS
PMX B

RECEIVERS and RI/FI METERS
R RW-T CFI
TR FIM-2 IC-120
ANTENNAS

LABORATORY EQUIPMENT
PJ-1 P-3 MP-1A
N-1 KLYSTRONS K-200

Name.....Title.....
Dept. or Station.....Company.....
Address.....
City.....Zone.....State.....
My major fields of interest and activity are:.....
.....

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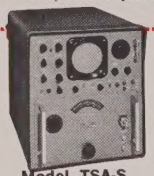
World Leader in Microwave Instrumentation

SPECTRUM ANALYZERS—10-100,000 MC

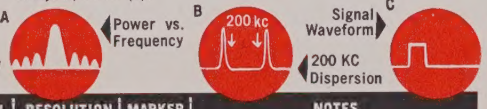
Undisputed leader in the field of microwave spectrum analysis, Polarad offers the widest, most diversified line of equipments for precise and meaningful quantitative and qualitative evaluation of any signal, regardless of complexity or frequency content. The features listed below are generally common to all Polarad Spectrum Analyzers:

- Direct-reading UNIDIAL® tuning —no klystron mode-setting!
- Frequency Dial Accuracy, ±1%
- Sweep-rate adjustable, 1-30 cps
- Non-contacting klystron-cavity chokes for noiseless tuning, optimum stability
- Five-inch flat-face CRT display
- Compatible with Multi-pulse Spectrum Selector SD-1

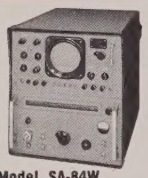


Model TSA-S
Dual-Purpose Spectrum Analyzer/ Synchroscope

TSA SERIES. 10-44,000 MC in 5 plug-in tuning units. Model TSA provides power vs. freq. display (A), below. Model TSA-S provides both (A) and synchroscope display (B). Wide-dispersion Model TSA-W provides (A) display, up to 80 MC (full screen), down to 60 KC for wide pulse analysis, as in (C).



MODEL	DISPERSION	RESOLUTION	MARKER	NOTES
TSA	25 KC-25 MC	1-80 KC	±14 MC	Sensitivity —50 to —100 dbm
TSA-S	400 KC-25 MC	5/50/500 KC and 5 MC	±14 MC	Sensitivity —50 to —100 dbm. Synch. Sweep Rates: 2 μsec to 0.1 sec/cm
TSA-W	25 KC-80 MC	1-80 KC	±40 MC	Sensitivity —50 to —100 dbm Displays spectra of 0.1 μsec pulses

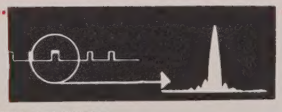


Model SA-84W
Wide-Band Spectrum Analyzer

SA SERIES Universal Spectrum Analyzers provide complete coverage from 10-40,880 MC in compact, self-contained form. The new lightweight transistorized unit Model SA-84T is truly portable, and will operate from either the AC line or 12 V DC. The SA-84W wide-band design features exceptionally broad frequency coverage and very wide dispersion in a single-unit package.

Model SA-84T
Transistorized Portable

MODEL	DESCRIPTION	DISPERSION	RESOLUTION	NOTES
SA-84T	Transistorized Universal	400 KC-25 MC adjustable	20 KC	Internal Marker, ±13 MC Sensitivity, —50 to —105 dbm.
SA-84	Standard Universal	500 KC- 5 MC (up to 55 MC) 500 KC-25 MC (above 55 MC) adj.	20 KC	Variable Internal Marker comparable sensitivity to SA-84T
SA-84W	Wide-Dispersion Universal	25 KC-10 MC 25 KC-80 MC 240 to 40,880 MC	1-80 KC variable	Crystal-controlled markers over entire freq. range. Log-linear display. Accurate IF attenuator. Comparable sensitivity to SA-84T



MULTI-PULSE SPECTRUM SELECTOR: When used with any Polarad Spectrum Analyzer, this instrument permits isolation and spectrum analysis of any individual pulse in a complex coded signal.

Model SD-1

MODEL DA-70, 50-100 KMC Spectrum Analyzer. Dispersion adj. 50-1000 MC. Resolution 1 MC. High IF assures image rejection, prevents video detection. Sensitivity, —50 dbm, nom. Frequency marker for △F measurements.

MODEL WSA Wide-Band Spectrum Analyzer. 10-40,000 MC in 20 push-button-selected bands. Narrow mode: 1-25 MC dispersion, 20 KC resolution. Wide mode: 50-4,000 MC dispersion, 1.5 MC resolution. Freq. marker to 4 KMC. End-markers indicate band limits. Center-marker for wide-to-narrow switching without signal loss.

Model WSA

USE THIS CARD for complete specifications or call your local Polarad representative (see the Yellow Pages).

SIGNAL GENERATORS—0.5-50 KMC

Model PMR
UHF Signal Generator

MSG-2R
Signal Generator

Model MSG-34
Ultra-Broadband Signal Generator

500-11,000 MC SERIES. These superb instruments incorporate every important mechanical and electronic advancement known to the art, including several Polarad exclusives, such as UNIDIAL® tuning. Direct-reading frequency dials, accurate to ±1%. High-stability non-contacting klystron-cavity shorts for noiseless tuning, permanent accuracy. Continuously-variable, directly-calibrated attenuators. Modulation: internal pulse, FM, sq-wave; external pulse and multi-pulse. Delayed and undelayed sync. outputs. The Model PMR provides exceptional FM capability through the use of a special plug-in modulator (supplied).

MODEL	FREQUENCY-KMC	CALIBRATED POWER OUTPUT	INTERNAL MODULATION
PMR	0.5 - 1.0	0.5 MW (—3 dbm) to —127 dbm	sq-wave, 40-4,000 pps } FM with plug-in Pulse, 10-10,000 pps } modulator
KSS (Signal Source)	1.05-11.0 (4 plug-ins)	Uncalibrated. Power Output: 14-400 MW, depending on freq.	sq-wave, 10-10,000 pps (external pulse, sq-wave, FM)
PMX	4.45-11.0 (2 plug-ins)	1 MW (0 dbm) to —127 dbm	All instruments in this group: pulse modulation: 10-10,000 pps. *pulse width: 0.2-10 μsec. pulse delay: 2-2,000 μsec. square-wave modulation: 10-10,000 pps. FM deviation: ±2.5 MC min. *0.3-10 μsec. in MSG-1R and 2R.
MSG-34 (Ultra Broadband)	4.2 -11.0 digital freq. indicator	1 MW (0 dbm) to —127 dbm	
MSG-1R	0.95- 2.40	1 MW (0 dbm) to —127 dbm	
MSG-2R	2.0 - 4.60	1 MW (0 dbm) to —127 dbm	

MULTI-PULSE CODE-MODULATED MICROWAVE SIGNAL GENERATOR

Model B — 0.95 to 10.75 KMC 4 plug-in tuning units. 5 independent adjustable channels, each with variable pulse width and delay. Built-in precision scope.

EHF SERIES Signal Generators (frequency and power calibrated) and Signal Sources (frequency calibrated) operate CW, with 1 KC int. modulation, or ext. mod'n. See chart for tuning unit ranges and designations. Also available: SG-1218 Generator or SS-1218 Source, 12.4-17.5 KMC.

EHF Series
Signal Generators

EHF SIGNAL GENERATOR Tuning Unit	Frequency Range	EHF SIGNAL SOURCE Tuning Unit
G1822-1	18,000 to 22,000 mc	S1822-1
G2225-1	22,000 to 25,000 mc	S2225-1
G2427-1	24,700 to 27,500 mc	S2427-1
G2730-1	27,270 to 30,000 mc	S2730-1
G3033-1	29,700 to 33,520 mc	S2933-1
G3336-1	33,520 to 36,250 mc	S3336-1
G3540-1	35,100 to 39,700 mc	S3540-1
	39,600 to 46,000 mc	S4046-1
	45,900 to 50,000 mc	S4650-1

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